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Proceedings of
Symposium on Human Ecology

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Proceedings of
Symposium on Human Ecology

Airlie House, Warrenton, Va.; November 24–27, 1968

Sponsored by the Consumer Protection and Environmental Health Service
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INTRODUCTION

THE BIOSPHERE—that part of our world which supports life—is but a thin veneer encasing the globe. In proportion to the earth's size, the layer of air which surrounds it is no thicker than the skin on the surface of an apple. A shallow crust on the earth's surface provides a limited supply of water and other resources on which all life depends and which is constantly recycled and reused in support of the life process.

That all elements in this closed life system, including man himself, are related and interdependent is so fundamental a truth that it is perceived intuitively by primitive peoples. Man's close relationship to nature was conceptualized, and even systematized, by the ancient scientists and philosophers, and the unchanging laws that govern the universe have long been recognized—if not, of course, fully understood. Yet, for all his science and philosophy, man has behaved for most of his time on earth as though he and his actions were exempt from the natural laws that govern his ecosystem. Required, as are all living things, to use to his own advantage the resources of the earth, man alone is capable of creatively cooperating with the natural processes to insure his continued survival and progress. Yet he has used these resources as though he could heedlessly exploit, contaminate, and alter the world about him without endangering the stability and harmony of the system of which he is a part. So long as his numbers were small, and his impact on the environment remained limited and localized, he did not have to pay the price for his shortsightedness; having spoiled one part of the earth, he could move on and leave to nature the long task of repairing the damage.

But recent history has changed all that. Human population has soared. Almost incredible advances in science and technology have given man a new and awesome power to alter—or even destroy—his environment. His skill and ingenuity in manipulating the environment have produced tremendous benefits to human life. But, more and more, these benefits have been accompanied by frightening, and sometimes irreversible, changes in the ecological system of which he is an integral part. Man has seriously depleted the world's natural resources, and devastated much of the earth's surface. The waste products of his technology and of his own biological processes have grossly polluted the land, air, and water. Moreover, 20th century man is beginning to discover that his basic social and psychological drives are increasingly frustrated by pressures of the artificial, urbanized world which he himself has constructed.

In our own Nation—the most technologically advanced in the world—streams and lakes are dying before their time. Birds, fish, and other wildlife are threatened with extinction. Human health is already affected by the psychic-socio stress of an urbanized industrial environment and by the barrage of microbiological, chemical, and physiological insults which man has injected into his environment, and the very survival of future generations may be threatened by the seemingly endless buildup of pollutants. Even therapeutic drugs, with their manifest benefits, pose subtle threats when considered as part of the total chemical assault sustained by modern man. And thousands of useful products, from fabrics to television sets, offer potential injury hazards.

Inhabitants of our great cities—which were once envisioned as the repository of all that was finest and best in civilization—are assailed by pollution, noise, crowding, and other unwelcome byproducts of modern urban life. For the urban poor, these conditions, and the social and cultural deprivation which accompany them, have reached an almost intolerable stage, while the pell-mell flight from urban life has produced the acres of unplanned housing that characterize our "suburban sprawl." Misuse of our farms and forests has caused us to coin another new term—"rural blight." Among even the most fortunate, there is a growing uneasiness that the benefits of man's technological progress have been attended by a subtle and almost incomprehensible degradation in the quality of life. For modern man, must the "pursuit of happiness" take place on a clogged commuter highway and find fulfillment in the successful search for a parking place?

On July 1, 1968, the Consumer Protection and Environmental Health Service, in the Department of Health, Education, and Welfare, was established by Executive order of the President to provide a new impetus and direction to our Nation's scattered efforts to maintain an environmental relationship conducive to the health and well-being of man, as citizen and consumer. The new Service is concerned with the whole spectrum of environmental and consumer hazards and brings together the principal activities of the Department of Health, Education, and Welfare which deal with these problems.

The Service's principal mission is to define human environmental needs on the basis of our developing knowledge of human ecology and to enunciate these as clearly as possible. Its aim is to assure that considerations of human health and welfare become, throughout our society, a guiding principle, in all actions affecting the environment. It expects to provide a continuing focus on man which all too often has been left out of the environment affecting decisions of our production-oriented, technological society.

Soon after its organization, the Consumer Protection and Environmental Health Service hosted ~~165 distinguished~~ representatives of various professional fields concerned with man and his environment at a 3-day Symposium on Human Ecology and to share their viewpoints and recommendations with its principal officials. Included in the group were physical, natural and social scientists, engineers and physicians, representing government, industry, and academia.

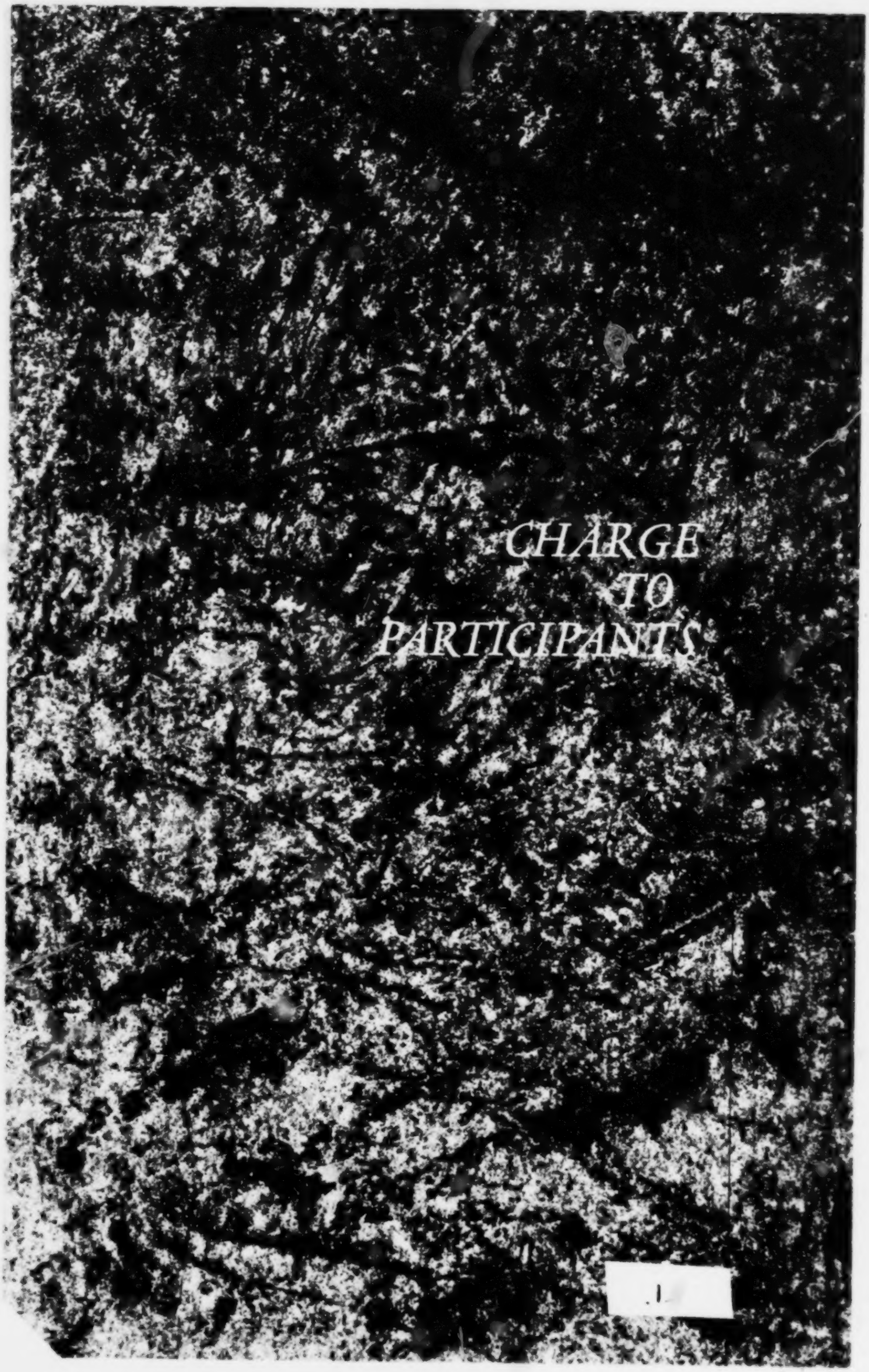
In its multidisciplinary approach—in the quality of its formal presentations—in its opportunity for free and unchanneled discussions—and, in the far-reaching significance of its recommendations, the Symposium was a truly unique undertaking.

There can be no doubt that it has made an important contribution to our Nation's understanding of its environmental and consumer problems. If its recommendations can be translated into action, this Symposium may truly mark "a turning point in our national approach to the problems of human ecology," a hope voiced by the Administrator of the Consumer Protection and Environmental Health Service in his charge to the participants.

These Proceedings include the formal papers presented ~~at the Symposium~~, summaries of the plenary discussions that followed, a digest in topical style of the small-group meetings, and a summary of the concluding session.

The Consumer Protection and Environmental Health Service believes that this published record will be of interest, not only to those who have a professional interest in or responsibility for some aspect of human ecology, but to the thousands of concerned citizens who, recognizing the pressing problems and needs of our time, are demanding appropriate action "now."

Consumer Protection and Environmental Health Service
Department of Health, Education, and Welfare



CHARGE TO PARTICIPANTS

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Charge to the Human Ecology Symposium

CHARLES C. JOHNSON, JR., *Administrator*
Consumer Protection and Environmental Health Service
Public Health Service
U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Synopsis

THE NATION must face the fact that, in spite of tremendous advances in medicine, science, engineering, and technology, it has not succeeded in creating a physical, social, and cultural environment that provides satisfaction for the "whole man." With regard to the physical environment, we have reached, or at least are rapidly approaching, a critical point. The quality of urban life, particularly, is deteriorating in a morass of environmental problems so complex as to appear almost beyond remedy.

For some years the Department of Health, Education, and Welfare has been engaged in a variety of programs to deal with these problems. Now, in recognition of the interrelationship and interdependence of all environmental factors which affect man, it has established the Consumer Protection and Environmental Health Service (CPEHS) to provide national leadership in meeting our environmental and related consumer needs. To achieve more effective and concerted action, all departmental activities relating to these problems have been placed in the new Service.

Unless the Nation learns and learns quickly to apply the scientific knowledge we now have—and it will always be incomplete—to the problems of the environment, we are courting inevitable disaster.

The Consumer Protection and Environmental Health Service expects to provide new impetus and direction to the Nation's efforts to deal with problems of human ecology—problems beyond the scope of any single agency acting alone—and specifically to provide that focus on man without which all ecological considerations become purely academic. It intends to make common cause with all other organizations and movements concerned with environmental and consumer problems.

—CPEHS will give first priority to the development of broad environmental criteria based on current understanding of human health and well-being.

—CPEHS intends to use its regulatory authorities fully and fairly, and to seek new authorities where needed. It intends to work closely with industry, government, and academia at all levels to achieve prevention or control of environmental hazards. It intends to work with State and local jurisdictions to help them develop broad, effective environmental and consumer protection programs. It intends to be responsive to the needs of our people, as citizens and consumers, in their quest for a better life.

This symposium is asked to provide recommendations which will be useful to CPEHS as it moves ahead in discharging its mission.

FIRST, let me again say how pleased and grateful I am to have you here at this symposium. My staff and I look forward to our discussions with you. I hope that in the years to come you will be able to look back on these few days as a gathering of minds that truly marked a turning point in our national approach to the problems of human ecology.

The Department of Health, Education, and Welfare has established the Consumer Protection and Environmental Health Service to provide a new and broader kind of national leadership in dealing with these problems and specifically to provide that focus on man without which all ecological considerations become purely academic.

We approach our new task, not with optimism—for no one who looks at what we have done to ourselves and our planet in a comparatively few years can be guilty of optimism—but with determination. Secretary Cohen has charged the new Service with making this "a cleaner, safer, more healthful land for all." And we do feel sure that it can be done. Man, as a rational being, did not set out deliberately to destroy or contaminate the earth that gives him life, and surely he cannot, once the consequences are made clear, persist in a course which clearly leads to environmental chaos or even self-destruction. We are therefore moving ahead as quickly as possible to create a program whose impact will be felt throughout our society.

As we set about creating such a program, we need the best advice, the best guidance, possible. That is why I have asked this outstanding group to come together and consult with us. I am confident you will be able to give us a deeper insight into the man-environment relationship, assist us in defining the constants and the variables of human ecology, and help us avoid the pitfalls which surely lie ahead.

We live in troubled times, and they show all too clearly the terrible interplay of forces between man and the whole biocommunity of which he is a part. We find ourselves today catapulted into a new kind of world which we approach as strangers in a strange land. At times, the very structure of society seems in danger of being overwhelmed by a torrent of technological change which man has set in motion but sometimes seems incapable of controlling. Urbanization, a soaring population, and inequities nurtured in the darkness of the past and long ignored have released a slumbering discontent which jars the very foundations of the American dream. In our cities, this discontent has shown itself in attempts to destroy what no longer seems tolerable. Among our young people, there is a kindred frustration—and they would turn their backs on a society which they find "irrelevant."

In the year 1968, the greatest Nation in the world must face a harsh and frightening fact: In spite of our tremendous advances in medicine, in science, engineering, and technology; in spite of a lengthening span of human life through improved health services and victories over communicable disease; in spite of affluence and high standards of living; in spite of all these things—perhaps even because of these very things—we have not succeeded in creating a physical, social, and cultural environment in which we can find that satisfaction for the "whole man" which was surely the purpose of all our strivings.

With regard to the physical environment, we have reached, or at the very least are rapidly approaching, a critical point. Every year, pollution gets worse, rather than better; the threat from unsafe food, drugs, water, and a variety of consumer products is increasing; the quality of American life, particularly urban life, is deteriorating in a morass of environmental problems so complex as to appear almost beyond remedy.

In the image of our adventurous ancestors, we are always drawn to the distant frontier and find it easy to close our eyes to the unplowed field that lies in front.

We are challenged by the potential miracles of organ transplants—while we drop steadily backward in such measures of medical progress as infant mortality. (We ranked sixth among the nations of the world in 1950 and by 1961 had moved down to about 15th place.)

We are about to land a man on the moon—and have not yet figured out what to do with the growing mountains of trash that litter our countryside.

Believe me, I do not question the value of these explorations whether they be in space or in medicine—but I am reminded, and I think our generation needs to be reminded, of that old proverb: "A man gazing at the stars is at the mercy of the puddles on the road."

Certainly our progress in meeting human needs has been great, but it has been uneven and our failure to come to grips with our consumer and environmental problems has—as the saying goes—been worse than a crime; it has been a blunder.

Let me, very briefly, review for you just a few more of the problems that demand our attention:

Toxic matter is being released into the air over the United States at a rate of more than 142 million tons a year, or three-quarters of a ton for every American. It comes from 90 million motor vehicles, from factories, powerplants, municipal dumps, and backyard incinerators.

The use of food additives to impart flavor, color, or other qualities has increased 50 percent in the past 10 years, and each of us now consumes an average of 3 pounds of these chemicals yearly. Pesticides leave residues on food crops, and traces of veterinary drugs occur in meat, milk, and eggs—all this in addition to the chemical barrage that reaches us from other parts of the environment.

Over 2 million Americans are stricken with illness each year from microbiological contamination of food; increased use of "convenience" foods requiring little or no heating in the home complicates this problem.

Not counting industrial and agricultural wastes, we discard more than 165 million tons of solid wastes every year. Auto graveyards mar our landscapes; smoking, foul-smelling dumps pollute the air; no-return bottles, cans, and other packaging that cannot be recycled create mountains of trash. In low-income urban areas, garbage breeds rats, disease, and filth.

Every year, more than 500 new chemicals and chemical compounds are introduced into industry, along with countless operational innovations; thousands of workers suffer from cancer, lung disease, hearing loss, dermatitis, or other preventable diseases because industry, unions, and government at all levels have failed to give really adequate attention to occupational hazards.

Much of the drinking water available in our Nation's communities is of unknown quality. There are over 19,000 communities whose public water supplies serve about 58 million people which are not covered by U.S. Public Health standards. About 750 community water supplies serving about 92 million people are covered, but the standards themselves need updating, particularly with regard to chemical contaminants.

Accidents—many of them involving hazardous products—take the lives of 100,000 Americans every year and injure 52 million more. Some 3,000 deaths occur every year from accidental ingestion of poisons—most of these among children.

Radiation as an environmenetal hazard is a growing threat to ours and future generations which we have barely begun to understand. Radiation sources are now to be found throughout the environment. They range from the large-scale applications of nuclear energy, particularly in electric power generation, through laser and microwave technology in industry, to the use of radionuclides and X-rays in the healing arts and the use of microwave ovens and other electronic equipment in the home. And our scientific protection against radiation is at a beginning stage of development.

The world clamors for the thousands of new miracle drugs which our pharmaceutical research produces to treat specific disease problems. Yet in spite of our best efforts at testing, labeling, and other controls, they often produce unforeseen side effects and may even offer sinister genetic threats. What these new chemical formulations mean in terms of the total chemical barrage to which modern man is exposed is an area we have not even begun to explore.

Scientist-philosophers like Dr. Dubos and others in this distinguished company have pointed out for years the hazards of our heedless and random manipulation of the ecological system. As a Nation, we have been slow to understand, and even slower to act—and yet we have not remained completely idle.

For some years, the Department of Health, Education, and Welfare has been engaged in programs to assure safe food, drugs, and drinking water; to control air pollution, occupational disease, radiation hazards, and other environmental threats. In the last few years, we have attempted to adopt a broader, more comprehensive approach to these problems. We have established a national laboratory for environmental health research. We have tried several organizational alinements in an effort to create more effective action. We have recognized that several of our diverse activities—in food protection, sanitation, safe drugs, clean air, and the like—all relate to the same overwhelming problem, the problem of man's ability or inability to adapt to an environment which he himself is subjecting to constant change.

But although our perception of the man-environment relationship matured and clarified and although our sense of urgency grew, we in Health, Education, and Welfare, no less than the rest of the Nation—seemed unable to translate this new understanding and urgency into meaningful action, with man—the whole man—as the focus of our efforts.

Even as the holistic nature of the man-environment relationship became an article of faith with us, we somehow still remained too often locked into narrow, categorical approaches to our environmental problems. And in spite of broader concepts of human health and a growing understanding of the whole man, we have unquestionably limited ourselves to too narrow and rigid a definition of environmental health. We have thought that before we could prove health hazards in the environment we had to be able to count the corpses—and furthermore to establish a direct, incontrovertible causal relationship, based on immutable scientific data in strict accordance with Koch's Postulates. Unfortunately, in an environment of multiple impacts, direct, incontrovertible causal relationships between health and individual insults are difficult to define even when the evidence is abundantly clear. Furthermore, science is never immutable; what we know today is always modified by what we learn tomorrow.

Unless our Nation learns and learns quickly to apply the scientific knowledge we have—and it will always be incomplete—to the problems of the environment, we are courting inevitable disaster.

We in Health, Education, and Welfare have at last in our organizational structure, taken into account the interdependence and interrelatedness of all environmental factors in their effect on man. We have brought together in a situation in which they can be mutually supportive the Food and Drug Administration, the National Air Pollution Control Administration, and the Environmental Control Administration. We intend to provide coordination to our total effort. We want to assure that no important line of research is neglected. And, most importantly, we want to consolidate all that we know today—and all the knowledge that we can develop in the future—into a sensible, revealing picture of what is happening to man in the contemporary environment.

It is our purpose to define as well as possible, and to enunciate as clearly as possible, the effect on man—the combined and total effect wherever this can be determined with some degree of validity—of the various environmental impacts to which he is subjected. We intend to give first priority to the development of broad environmental criteria based on our current understanding of human health and well-being; we hope such criteria can become the baseline for the thousands of daily decisions, in both the public and private sector, which determine the kind of world we live in.

We suffer no illusion, either as to our own limitations or the difficulty of the task. We cannot manage the environment, and no single agency of government can do so. For just as every human activity has contributed to our environmental problems, every human activity—probably without exception—is going to have to be involved in their solution.

No agency of government can single-handedly design and build transportation systems, and cities, and industrial plants; it cannot remove pollution from the air, and assure pure drinking water, and uncontaminated food. Consumer Protection and Environmental Health Service cannot single-handedly rebuild our ghettos, or update our sewage systems, or eliminate the noise and stress and crowding that mar the quality of our lives. It cannot construct a safe and healthful environment for every American.

But we in the Consumer Protection and Environmental Health Service *can* provide the focus on human health and welfare which is so essential to the attainment of these vitally important goals. And all Americans, working together, can transform the face of the Nation, if we are determined to put science and technology to work to solve the very problems science and technology have created.

We intend to use those regulatory authorities vested in us fully and fairly, and to seek new authorities where we find they are needed. We intend to work closely with industry and government of all levels to achieve prevention or control of environmental hazards. We intend to work with State and local jurisdictions to help them develop broad, effective environmental and consumer protection programs. And, as I emphasized earlier, we intend to develop criteria which can guide their action.

We intend to become the spokesman, not just for conservation or pollution abatement or food and drug protection or sanitation, but for man the citizen and consumer. We intend to become the advocate and spokesman for human ecological wisdom *applied* throughout our society.

We intend to make common cause with all the other organizations and movements that are concerned with any aspect of the environmental problem. And we hope that by providing a more meaningful focus on man, we can weld all these separate approaches into a coherent and effective design for national action.

Never before has there been such general public concern about the quality of the environment. Increasingly, as environmental deterioration has more and more affected the lives of all, uneasiness on the part of all has created a demand for more sensible use of the environment. Universities and other private organizations have turned their attention to the problem. State and local governments have established programs to cope with various aspects of it. Industry has shown increasing awareness of its responsibilities. Throughout the Federal structure, agencies charged with such matters as transportation, natural resources, city planning, and agriculture, are thinking in terms of environmental impact and striving to reconcile their actions with some elusive principle of ecological wisdom.

And yet, our national efforts have not been effective in holding back the tide of environmental ills. The Nation as a whole has failed, I think, to grasp the complete meaning of what Dr. Dubos and others have tried to tell us—that the object of our concern is, or certainly ought to be, man. In our search for neat, single solutions to neat, single problems, we have tended to classify them as though they were parts of an exercise in planetary property management. We have looked too long through the wrong end of a telescope, and have lost sight of the principal figure which should demand our attention—man himself. As "Action Is the Child of Thought," obsolete thinking has produced—in accordance with the immutable laws of nature—obsolete actions.

If we are going to replace outworn attitudes with new ones, all of the disciplines and institutions which in the past have been concerned with man's environment must reexamine their traditional positions. In the field of public health, only a few pioneers have shown real concern for the important role of environmental factors in the causation of disease and disability. We set up clinics in rural and city slums where we patiently treat and re-treat the same child for recurring bouts of diarrhea, for instance—without ever concerning ourselves with the environmental source of the infection. We set up mental health clinics which try to mitigate the terrible effects of poverty and ignorance and degradation, but regard an attack on the causes as beyond our province. Too many public health workers in short, are still capable of showing genuine compassion for the person who is already ill or injured, coupled with genuine indifference to the environmental causes.

For years, our conservationists have been "voices crying in the wilderness" maintaining the ecological truth that man cannot be totally estranged from the natural world and remain whole. They have helped stem the tide of devastation.

But their efforts, too, must be attuned to a broader ecological view—that relates the "Natural environment" to the "Man Made" urban environment in truly meaningful ways. Pesticides *do* threaten the balance of nature, and water pollution is *indeed* destroying aquatic life, and the effect of sonic booms will assuredly be felt by wildlife in our wilderness areas. But all of these things, it must be made clear, are important fundamentally because they have sooner or later an adverse effect on man himself.

Those who are concerned primarily with preserving and enhancing the beauty of the world about us are in possession of a higher order of ecological grace than most of the rest of us, for they never forget that "man does not live by bread alone." But their efforts, too, must be taken in awareness of the complex interrelatedness of all environmental problems; otherwise their best efforts could do no more than erect visible barriers between man and the ugliness he has created.

Those who are concerned with the consumer must recognize that he is also a citizen, and the hazards to which he is subjected go beyond those of contaminated milk and food, hazardous products, etc. They include the air he breathes, the water he drinks and the many hazards which he encounters as he moves through the environments of home, job, and neighborhood. With regard to their effects on him, the environmental hazards he encounters as a citizen cannot be differentiated from the hazards to which he is subjected as a consumer.

I hope that we can provide for all of these various groups a common view on the problem of human ecology and give new impetus and definition to all their efforts. And I hope that we can establish some new priorities for saving the environment.

As for the future, the population of the United States now numbers 200 million and is expected to reach at least 230 million by 1980; urban areas will absorb the increase, and their environmental problems will be intensified. Technology may be expected to increase the risk of food-borne disease and chemical contamination. Unless we apply the lessons of human ecology the future can only bring more physiological, biological, and psychological hazards for man.

We in the Consumer Protection and Environmental Health Service hope that we can help America apply these lessons. We will certainly need help in doing so. Your charge, then during these 3 days of discussions, is to distill the varied and vast body of knowledge which you represent into a series of recommendations which we can consider as we strive to carry out the mission with which we have been charged.

ISSUES

11

The Crisis of Man in His Environment

Dr. Rene Dubos
The Rockefeller University

Synopsis

HUMAN ECOLOGY involves a consideration of the adaptive responses of man to the demands of his environment as an expression of his place on a health-disease continuum.

During the past century advances in health have come about chiefly as a result of a higher standard of living and from the application of natural sciences to the prevention of infectious and nutritional diseases, and not solely through therapeutic procedures. The genesis of our medical problems are to be found largely in the man-environment relationship. Greater knowledge of and attention to the environmental determinants of disease would certainly constitute the most important element in helping biomedical sciences improve human health.

Unfortunately, adaptative responses to the stresses of a changing environment often expresses itself, at some future date, in the form

of overt disease and disability. An environmental setting which allows man to be productive economically during his working years, should be regarded as unacceptable if it contributes to disease later in life. Influences early in life, experienced during the formative phases of development, deserve special emphasis and study because they exert profound and lasting effects on the characteristics of the adult. One of the important problems of human ecology is to study the effects of environmental forces on the development and future health status of the human organism.

What is required is nothing less than a bold imaginative departure from orthodoxy and the creation of a new science of environmental biomedicine—a systematic science of total man in his total environment—emanating either outside the university complex, or in new academic institutions not yet committed to the orthodox fields of science. The social need for such a fresh, bold approach is acute.

FOR MOST LAYMEN and not a few scientists, the work environment evokes nightmares—the toxic effects of chemical pollution, the behavioral disturbances caused by crowding or automated work, the pathologic consequences of exposure to intense and unnatural stimuli, the thousand devils of the ecologic crisis.

Physicians have long known, furthermore, that sudden changes in the ways of life and in the surroundings are likely to have damaging effects on biological and mental health. In brief, the modern environment is dangerous on two accounts: It contains elements that are outright noxious; it changes so rapidly that man cannot make fast enough the proper adaptive responses to it.

The general worry about the environment has resulted in a distortion of the meaning conveyed by the phrase "human ecology." At present, this phrase is exclusively identified with the social and biological dangers that man faces in the modern world. But there is more to human ecology than this one-sided view of man's relation to his environment. In the long run, the most important aspect of human ecology is that all environmental factors exert a direct effect on the development of human characteristics, in health as well as in disease. In fact, it can be said that the body and the mind are *shaped* by the adaptive responses that man makes to the physiochemical, social, behavioral, and even historical stimuli that impinge on him from the time of conception to the time of death. Genetically and phenotypically, man is being constantly transformed by the environment in which he lives.

Human ecology therefore involves both the pathological and the formative effects of the total environment. I shall first illustrate by a few examples these two aspects of the problem, then attempt to formulate a general approach to the study of the interplay between man and environmental forces.

The general state of public health has greatly improved during the past century, but therapeutic procedures have played a relatively small role in this achievement. Advances in health and in the expectancy of life have come chiefly from higher standards of living, and from the application of natural sciences to the *prevention* of infectious and nutritional diseases.

Although the early sanitarians did not use the phrase "human ecology" their slogan "pure air, pure water, pure food" implied sound ecological concepts. Their awareness of the effects that environmental factors exert on biological health was furthermore supplemented by a shrewd understanding of man's emotional needs. For example, they advocated that urban areas be ornamented with trees and flowers and that city dwellers be given ready access to country lanes.

Thanks to their efforts, we have gone far toward solving the problems of infectious and nutritional disease generated by the first industrial revolution. Unfortunately, the new revolution in the ways of life and in the environment that is now occurring in technological societies is bringing about profound changes in the pattern of diseases, causing in particular alarming increases in various types of chronic and degenerative disorders.

Whereas the 19th century was concerned with malnutrition, overwork, filth, and microbial contamination, the diseases most characteristic of our times result in large part from economic affluence, chemical pollution, and high-population densities. The medical problems are still largely environmental in origin, but they have different ecologic determinants.

The average expectancy of life has increased all over the world and especially in prosperous countries as a result of the prevention of early deaths that used to be caused by acute infections and malnutrition. But, contrary to general belief, life expectancy past the age of 45 has not increased significantly anywhere in the world, not even in the social groups that can afford the most elaborate medical care. It is no longer permissible to take comfort in the belief that various types of vascular diseases, of cancers, of chronic ailments of the respiratory tract, have become more prevalent simply because people live longer in affluent societies. The increase in chronic and degenerative diseases is due in part at least, and probably in a very large part, to the environmental and behavioral changes that have resulted from industrialization and urbanization.

The so-called diseases of civilization are certainly the results of man's failure to respond successfully to the stresses of the modern environment. But, there is as yet no convincing knowledge of the mechanisms relating the environment and the ways of life to the increased incidence of chronic and degenerative diseases among adults. Granted the deficiences in etiological understanding, it is obvious nevertheless that man feels threatened and is threatened by the constant and unavoidable exposure to the stimuli of urban and industrial civilization; by the varied aspects of environmental pollution; by the physiological disturbances associated with sudden changes in the ways of life; by his estrangement from the conditions and natural cycles under which human evolution took place; by the emotional trauma and the paradoxical solitude in congested cities; by the monotony, the boredom, indeed the compulsory leisure ensuing from automated work. These are the very influences which are now at the origin of most medical problems in affluent societies. They affect all human beings, irrespective of genetic constitution. They are not inherent in man's nature but the products of the interplay between his genetic environment and the new world created by social and technological innovations. To a very large extent the disorders of the body and mind are but the expression of inadequate adaptive responses to environmental influences which differ drastically from the conditions under which man evolved.

As already mentioned, hardly anything is known concerning the natural history of the diseases characteristic of modern civilization—let alone concerning methods for their treatment. It is urgent therefore to develop a new science of human ecology focused on the conditions prevailing in the technological environment.

One can take it for granted that medical science will continue to develop useful techniques for treating cancers, vascular diseases, and other degenerative disorders; methods for organ transplants and for the use of artificial prostheses will certainly be improved during the forthcoming decades. But most of the conditions that will thus be treated need not have occurred in the first place. Greater knowledge of the environmental determinants of disease would certainly constitute the most important factor in helping biomedical sciences to improve human health. Prevention is always better than cure, and also much less expensive.

As presently managed, the technological urban civilization subjects all human beings to endless and dangerous stresses. Yet men of all ethnic groups elect to live in huge megalopolis, and indeed manage to function effectively in this traumatic environment. Most of them seem to develop tolerance to environmental pollutants, intense stimuli, and high-population density, just as they develop herd immunity to microbial pathogens that are ubiquitous.

The acquisition of tolerance, however, is not an unmixed blessing. Air pollution provides tragic evidence of the fact that many of the physiological, mental, and social processes which make it possible to live in a hostile environment commonly express themselves at a later date in overt disease and in economic loss. During the past two centuries, for instance, the inhabitants of the industrial areas of northern Europe have been exposed to large concentrations of many types of air pollutants produced by incomplete combustion of coal, and released in the fumes from chemical plants. Such exposure is rendered even more objectionable by the inclemency of the Atlantic climate. However, long experience with pollution and with bad weather results in the development of physiological reactions and living habits that obviously have adaptive value, since northern Europeans seem to accept almost cheerfully conditions which appear unbearable to a non-experienced person.

Unfortunately, adaptation to the stresses of the present often has to be paid in the form of physiological misery at some future date. Even among persons who seem to be unaware of the smogs surrounding them, the respiratory tract registers the insult of the various air pollutants. Eventually, the cumulative effects of irritation result in chronic bronchitis and other forms of irreversible pulmonary disease. Generally, however, this does not happen until several years later.

Chronic pulmonary disease now constitutes the greatest single medical problem in northern Europe, as well as the most costly. It is increasing in prevalence at an alarming rate also in North America and it will undoubtedly spread to all areas undergoing industrialization. There is good evidence, furthermore, that air pollution contributes to the incidence of various cancers—not only pulmonary carcinoma. It also increases the number of fatalities among persons suffering from vascular disorders. The delayed effects of air pollutants thus constitute a model for the kind of medical problems likely to arise in the future from the various forms of environmental pollution.

Noise levels that are accepted almost as a matter of course bring about a progressive impairment of hearing; pathogens that do not cause destructive epidemics because they are ubiquitous and have therefore elicited herd immunity can generate endogenous infections when resistance to them is decreased by physiological or mental stress; crowding, regimentation, or intense stimuli that become acceptable through habituation indirectly elicit physiological or behavioral disorders. In brief, most adaptive adjustments to deleterious influences are achieved at the price of bodily or mental disturbances later in life. Some at least of these disturbances contribute to the diseases of civilization.

From the point of view of the general biologist, an environment is suitable if it enables the species to reproduce itself and increase its population; but this concept is not applicable to man. An environment allowing man to produce a family and to be economically effective during his adult years should be regarded as unacceptable if it generates disease later in life. This of course is the case for many modern technological and urban environments, which rarely destroy human life but frequently spoil its later years.

Human ecology thus differs from orthodox biomedical sciences in the much greater emphasis that it should put on the indirect and delayed effects of environmental forces, even when these do not appear to cause significant damage at the time of exposure.

Man's responses to the environmental forces that impinge on him determine to a very large extent how his genetic potentialities are converted into existential, phenotypic reality.

Contrary to what is commonly assumed, genes do not determine the traits by which we know a person; they only govern the responses he makes to environmental stimuli. Such responses become incorporated, usually in an irreversible manner in the person's whole being and thus mold his individuality. This is true not only for emotional characteristics, but also for most other physical, physiological, and mental characteristics. Man makes himself in the very act of responding to his environment through an uninterrupted series of feedback processes. Since each person continues to respond to environmental stimuli throughout his life and to be lastingly modified by such responses, individuality can be defined as the continuously evolving phenotype.

Many of the most striking differences in size, shape, attitudes, and mental abilities between ethnic groups are not innate; they are the expressions of environmental influences. In other words, men are as much the products of their environment as of their genetic endowment. This is what Winston Churchill had in mind when he asserted "We shape our buildings, and afterwards our buildings shape us."

The influences experienced very early in life during the formative phases of development deserve special emphasis, because they exert profound and lasting effects on the anatomical, physiological, and behavioral characteristics of the adult. Experimentation in animals and observations in man have revealed that the fetus and the newborn can be so profoundly affected by environmental conditions acting indirectly through the mother, or directly after birth, that the adult reflects throughout his life the consequences of this early experience. Early influences are of particular importance because man's body and brain are incompletely developed at the time of birth. Hence, the need for precise observations and searching experimental studies concerning the conditions of prenatal and early postnatal life.

Biological and social deprivation are well known to have deleterious effects on development. For example, there is now overwhelming evidence that various types of deprivation early in life exert irreversible damage on learning ability—a fact of obvious importance in all underprivileged populations. On the other hand, it is also possible that some of the conditions prevailing in affluent societies have undesirable consequences.

It is known that injection into newborn mice of particulate material separated from urban air greatly increases the frequency of various types of tumors during the adult life of these animals. If this observation can be extrapolated to human beings, the worst effects of environmental pollution are yet to come, since it is only during the past decade that large numbers of babies have been exposed to high levels of pollutants in urban areas.

It is known also that animals offered a rich and abundant regimen early in life thereby become conditioned to large nutritional demands as adults and tend to become obese. This may explain why the bigger baby does not necessarily become a healthy adult.

By acting on the child during his formative stages, the environment thus shapes him physically and mentally, thereby influencing what he will become and how he will function as an adult. For this reason, environmental planning plays a key role in enabling human beings to acutalize their potentialities.

Children who are denied the opportunity to experience early in life the kind of stimuli required for mental development, do not acquire the mental resources that would be necessary for the full utilization of their free will. It is not right to say that lack of culture is responsible for the behavior of slum children or for their failure to be successful in our society. The more painful truth is that these children acquire early in life a slum culture from which escape is almost impossible. Their early surroundings and ways of life at a critical period of their development limit the range of manifestations of their innate endowment and thus destroy much of their potential freedom.

It would be unethical and in any case futile to try creating one particular type of environment optimum for all of mankind. Such a course would impose a common pattern of development on all human beings and thus would be tantamount to suppressing their freedom. Society should instead provide as wide a range of environmental conditions as practically and safely possible so that each human being can select the experiences most suitable to the development of his attributes and to the prosecution of his goals.

Human potentialities, whether physical or mental, can be realized only to the extent that circumstances are favorable to their existential manifestation. For this reason, diversity within a given society is an essential component of true functionalism; the latent potentialities of human beings have a better chance to emerge when the social environment is sufficiently diversified to provide a variety of stimulating experiences, especially for the young. As more and more persons find it possible to express their biologic endowments under a variety of conditions, society becomes richer and civilizations continue to unfold. In contrast, if the surroundings and ways of life are highly stereotyped, the only components of man's nature that flourish are those adapted to the narrow range of prevailing conditions.

Thus, one of the most important problems of human ecology is to study the effects of environmental forces not only in the here and now, but also with regard to their future consequences.

As seen from the preceding sections, the problems of ecology are conceptually very different from those of the orthodox biomedical sciences. The latter are primarily concerned with the structures and functions of the body and of the mind in their universal and essentially unchangeable aspects. This kind of knowledge is just as valid for stone age man as for the Beatles; it applies equally well to the man living in the jungles of New Guinea or in a New York City penthouse. Human ecology, in contrast is concerned with the problems emerging from the interplay between man and the various forces of the environment in which he develops and lives. Human ecology deals not with man in the abstract, but with particular men at a particular time in one particular place. The interplay between man's nature and his total environment is governed of course by general laws, but their manifestations differ greatly according to circumstances.

Human ecology involves not only the immediate and direct effects of environmental forces, but also their indirect and long-range consequences. Such knowledge cannot be obtained from the study of oversimplified biological systems. It requires the analysis of actual human situations and the use of experimental models reproducing some selected aspects of these situations. Fortunately, experience has shown that for almost all human problems, there exists in the animal kingdom several species suitable for the development of useful models; there is no doubt therefore that human ecology could be readily developed into a flourishing experimental science.

The following are a few examples of problems in human ecology that can be studied through the use of experimental models with animals:

1. Indirect and delayed effects of biologically active substances, such as drugs and environmental pollutants.

2. The effect of sensory stimuli—or lack of—and of other environmental conditions, on the development of sense organs and on physiological processes.

3. The effects of relative degrees of isolation or crowding on hormonal activities and behavioral patterns.

4. The acquisition of tolerance to injurious agents and situations; its distant consequences.

5. Enduring effects of perinatal influences; i.e., of the factors (nutritional, infectious, toxic, behavioral, etc.) that impinge on the organism during critical periods of its development (prenatal and early postnatal).

6. The conditioning of the response to any particular insult (of physiochemical; infectious, or behavioral origin) by the effects of the total environment on the host; i.e., the role of nonspecific etiological factors in epidemiology.

7. The necessity to keep social and technological innovations within a framework determined by the biological limitations of man.

8. The adaptive potentialities of the human organism at various stages of its development.

The phrase "adaptive potentialities" has been introduced above to emphasize once more that the environmental study of human life should not be limited to a consideration of pathological phenomena. Each person has a wide range of physical and mental potentialities that remain untapped. These become expressed phenotypically only to the extent that the person is given a chance to respond adaptively to the proper stimuli under the proper circumstances.

The problems of human ecology necessarily deal with complex situations in which several interrelated systems function in an integrated manner. Multifactorial investigations will demand new conceptual and experimental methods, very different from those involving only one variable, which have been the stock in trade of orthodox biology. They will require also research facilities which hardly exist at the present time. Almost any kind of animal or plant tissue will do for electron microscopy of cellular elements, or for analysis of intermediate metabolism. But the experimental study of responses and adaptation to environmental insults and stimuli is far more demanding. It will require the observation of human beings under a wide range of conditions. It will also demand new kinds of research facilities.

The following items immediately come to mind:

a. Experimental animals of known genetic structure and of controlled experimental past.

b. Quarters for maintaining animals under a wide range of conditions throughout their whole lifespan and indeed for several generations.

c. Large enclosures for maintaining animal populations of various sizes and densities, exposed to different types of stimuli.

d. Equipment (using telemetry) for observing and measuring responses without disturbing the experimental system.

e. Equipment for recording, retrieving, and analyzing the complex data to be derived from the study of large populations and multifactorial systems.

The mere listing of these facilities points to the need for new types of institutions with a special organization of highly integrated personnel. What is required is nothing less than a bold imaginative departure to create a new science of environmental biomedicine.

Needless to say, there does exist now a definite body of knowledge concerning man's interplay with his environment. But it is a highly episodic kind of knowledge, derived from attempts to solve a few practical problems. For example, research in human ecology has been stimulated by the training of combat forces for operation in the tropics or in the Arctic, by preparation for space travel, or by concern with brainwashing and the effects of solitary confinement. Useful as it is, the knowledge thus obtained is piecemeal and does not go far toward creating a systematic science of man in his environment.

In theory, this science could be and should be developed within the university. In practice, however, this will not be readily achieved. Universities are the reservoirs of classical knowledge, and still constitute the most important source of new knowledge. But their administrative structure—in addition to their educational responsibilities—make it difficult for them to develop the facilities and highly technical information required for solving the problems of rapidly changing societies.

Furthermore, the academic investigator insists, as he should, on his right to follow the internal logic of his intellectual interests. He is "discipline" oriented rather than "mission" oriented. Since human ecology derives its importance from social concerns rather than from its relation to orthodox biological disciplines, there is reason to fear that it will be given a low priority in the academic scale of values. The requirements of human ecology for new kinds of research facilities and for a change in intellectual approach will provide a ready excuse for neglect. In my opinion, this science will develop only if society recognizes that ecological knowledge is essential to its welfare, and if facilities for the procurement of this knowledge are provided either outside the university complex, or in new academic institutions not yet committed to the orthodox fields of science.

On several occasions in the past new fields of science have been developed outside the university in response to social needs.

For example: Agricultural experiment stations, supported by theoretical laboratories, were established throughout the United States in the late 19th century, because farming practices introduced from Europe were not suited to the natural conditions and social structures prevailing in most parts of the American continent.

Independent institutes of microbiology also were created all over the world at the end of the 19th century, because infectious processes were then the most important causes of death and disease. Medical schools did not undertake microbiological research until this science had been established in the new institutes.

Institutions devoted to aeronautics, space sciences, communication theory have recently been established outside universities (often by large industrial firms) to deal more rapidly with these new aspects of theoretical and practical knowledge. Several research institutes concerned with the nutritional problems peculiar to underdeveloped countries are now being sponsored by international organizations.

Thus, new research institutes commonly emerge in response to social demands. These institutes in turn affect the development of theoretical science by shifting the areas of emphasis—then they may or may not become incorporated in the university structure.

A last historical example will serve to illustrate how certain scientific fields must be nurtured outside the university system before they are accepted in the academic establishment.

At the beginning of this century, many physicians and laymen realized that medicine could not progress without more knowledge of the physiochemical bases of bodily functions. Medical schools, however, did not find it possible or even advisable to involve themselves in such a paramedical field. Fortunately, the founders of the Rockefeller Institute for Medical Research decided to take the responsibility for this task; they devoted large resources to the support of a kind of biomedical research that was then foreign to American medical schools. The prosecution of the physicochemical basis of medicine at the Rockefeller Institute gave intellectual recognition and glamor to this field in the United States. Within less than a quarter of a century, every important medical school tried to develop on its campus research facilities similar to those of the Rockefeller Institute.

The social need for human ecology is even more acute today than was the demand for a physicochemical basis of medicine at the turn of the century. For this reason it is essential to create new kinds of institutions to study the interplay between human life, technology, urbanization, and natural resources. One can expect that if investigators are given a chance to demonstrate the usefulness of human ecology, many medical schools and biological research institutes will consider as a legitimate aspect of their programs the interplay between man and his total environment. Historians of medical science will then discover the Hippocrates' treatise on "Airs, Waters, and Places" is a classical expression of what we now call "Human Ecology."

Summary of Discussion Following Dr. Dubos' Paper

A question and answer period following Dr. Dubos' presentation brought out the fact that medical schools must not only produce more physicians but must also change the curriculum to make the physician more aware of the total environment of man and the environmental etiologies of disease.

It may be necessary, in fact, to begin this training at the undergraduate level and even in high schools at seminars where students are conditioned to the importance of the environment and the complexities of environmental effects on man. For example, nutritional studies have shown the permanent cultural effects of environmental deprivation on subsequent development of the individual.

After a brief discussion on the clinical and subclinical effects of noise on man, the questions turned to how environmental priorities can be established as part of national goals and how they can be funded.

It was Dr. Dubos' view that many of the most significant developments in environment in the last 50 years have resulted from the crusaders who were skilled in the art of communicating their concerns and their anger to the public, culminating in legislation and other political action, rather than from scientists. It is necessary to discover more communicators in the interest of attaining goals of human ecology.

Social Benefit Versus Technological Risk

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Synopsis

HISTORICALLY our society has arrived at acceptable technological benefit-cost balances empirically—i.e., by trial, error, and subsequent corrective steps. Such a historical sequence creates an increasingly critical situation today for two reasons: (1) The well-known difficulty in changing a technical sub-system of our society once it has been woven into the economic, political, and cultural structures, and (2) the substantial reduction (roughly by a factor of ten) during the past century in the time span from the first use of a new technology to its widespread integration into our social system.

It has been abundantly clear for some time that predictive technological assessments, accompanied by an explicit scale of relative social values, are a pressing need. Because of the complexity of the relationship between the fundamental parameters involved in our societal "quality of life," it is a Herculean task to unravel the social values involved. However, it is possible to seek a few simple, hopefully useful, relationships that have been empirically established and for which historical information is available or can be derived.

In this study, the empirical relationship between public safety and social benefit is traced for a limited number of activities—such as use of electricity, mining accidents, general aviation, commercial aviation, and motor vehicle use. Illustrations are offered, together with some associated caveats and hypotheses, to show ways of approaching a rough answer to the question of "how safe is safe enough?" The results are applied to atomic power, as an example. The purpose of such an exercise is to illustrate a methodology for establishing performance "design objectives" appropriate for new technology entering into social use.

THE BROAD societal benefits of advances in technology exceed the associated costs sufficiently to make technological growth inexorable. This growth has been generally exponential in this century—doubling every 20 years in advanced technology nations. This technological growth has apparently stimulated a parallel growth in socio-economic benefits, and costs, although not at as rapid a rate.

The conventional socio-economic benefits—health, education, income—are presumably indicative of an improvement in the "quality-of-life." The cost of this socio-economic progress shows up in all the negative indicators of our society—urban and environmental problems, technological unemployment, physical and mental health, etc. If we understood quantitatively the casual relationships between specific technological developments and societal values, both positive and negative, we might overtly guide and regulate technological developments so as to maximize their social benefit/cost ratio. Unfortunately, we have not as yet developed such a predictive system analysis. As a result, our society historically has arrived at acceptable technological benefit/cost balances empirically—i.e., by trial, error, and subsequent corrective steps.

In advanced societies today, this historical empirical approach to optimizing technology creates an increasingly critical situation—for two basic reasons. The first is the well-known difficulty in changing a technical subsystem of our society once it has been woven into the economic, political, and cultural structures. For example, many of our environmental pollution problems have presently known engineering solutions—but the problems of economic readjustment, political jurisdiction, and social behavior loom as very large obstacles. It will take many decades to put into practice the technical solutions we know today. As a specific illustration, the pollution of our water resources is completely avoidable by engineering systems now available—but, in fact, public interest in making the economic and political adjustments to apply these techniques is very limited. It has been facetiously suggested that as a means for motivating the public, every community and industry be required to place its water intake downstream from its outfall.

In order to minimize these difficulties of adjusting technological applications, it would be desirable to experimentally try new developments in the smallest social groups that would permit an adequate assessment. This is a common practice in market testing a new product, or in field testing of the efficacy of a new drug. In both these cases, however, the experiment is completely under the control of a single company or agency, and the test information can be fed back to the controlling group in a time short compared to the anticipated commercial lifetime of the product. This permits achieving reasonably optimal use of the product in an acceptably short time. Unfortunately, this is rarely the case with new technologies. Engineering developments involving new technology are likely to appear in many places simultaneously and to become deeply integrated into our societal systems before their impact is evident or measurable.

This brings us to the second reason for the increasing severity of the optimization problem. It has often been stated that the time required from the conception of a technical idea to its first application in society has been drastically shortened by modern engineering organization and management. In fact, the history of technology does not support this conclusion. The bulk of evidence indicates that the time span from conception to first application (or demonstration) has been roughly unchanged by modern management, and depends chiefly on the complexity of the development.

However, what has been reduced substantially in the past century is the time span from first use to widespread integration into our social system. The techniques for societal diffusion of a new technology and its subsequent exploitation are now highly developed. Our ability to organize resources of money, men and materials to focus on new technological programs has reduced the diffusion-exploitation time by roughly an order of magnitude (a factor of ten) in the past century.

Thus, we now face a general situation that widespread usage of a new technological development may occur before its social impact can be properly assessed, and before any empirical adjustment of its social benefit/cost ratio is indicated.

It has been abundantly clear for some time that predictive technological assessments are a pressing societal need. However, even if such assessments become available, maximizing the social benefit/cost ratio also requires the establishment of a relative value system for the basic parameters in our "quality-of-life" objective. The empirical approach previously described implicitly involved an intuitive societal balancing of such values. A predictive analytical approach will require an explicit scale of relative values.

For example, if technology assessment of a new development predicts an increased per capita annual income of "*x*" percent, but also predicts an associated accident probability of "*y*" fatalities annually per million population, then how are these two compared in their affect on the "quality-of-life?" Because the penalties or risks to the public arising from a new development can be reduced by applying constraints, there will usually be a functional relationship (or trade-off) between utility and risk, the "*x*" and "*y*" of our example.

We have many examples of such trade-off relationships empirically determined. The automobile and airplane can be made safer if society would accept increased economic costs and lower performance. Environmental pollution can be removed to the degree that society will accept the economic costs and restrictions on use of pollutant sources. In these, and other cases, the trade-off process is actually one of continuous adjustment, with many portions of our social systems out-of-phase due to the many separate "time-constants" involved.

Because of the apparent complexity of the relationship between the fundamental parameters involved in our societal "quality-of-life," it is undoubtedly a Herculean task to unravel them. However, it is possible to seek a few simple, and hopefully useful, relationships that have been empirically established and for which historical information is available or can be deduced. In particular, the nationally important area of public safety provides such a potentially tractable subject. The ready availability of historical accident and health data, for a variety of public activities, provides an enticing quantitative stepping-stone to an evaluation of a particular type of social cost. The corresponding social benefits arising from these same activities are much less easily determined, but as will be shown later, some of them can be roughly determined.

In this study, therefore, I have undertaken to uncover the empirical relationship between public safety and social benefit for a limited number of activities. On the assumption that such historical situations have achieved a socially acceptable and reasonably optimum trade-off of values, any generalizations developed could then be used for predictive purposes. This approach might give a rough answer to the slyly simple question "how safe is safe enough?" The pertinence of this question to all of us, and particularly to governmental regulatory agencies, is obvious. Hopefully, a functional answer might provide a basis for establishing performance "design objectives" appropriate for technology entering into social use.

Societal activities fall into two general categories, those in which the individual participates on a "voluntary" basis, and those in which the participation is "involuntary," i.e., imposed by the society in which the individual lives. The process of empirical optimization of benefits and costs is fundamentally similar in both cases—namely a reversible exploration of available options—but the time required for empirical adjustments (the time-constant of the system) and the criteria for optimization are quite different in the two situations.

In the case of "voluntary" activities, the individual uses his own value system to evaluate his own experiences. Although his eventual trade-off may not be consciously or analytically determined, or based upon objective knowledge, it nevertheless is likely to represent, for that individual, a crude optimization appropriate to his value system. For example, an urban dweller may move to the suburbs because of a lower crime-rate and better schools, at the expense of increased highway travel time and accident probabilities. If, subsequently, the traffic density increases, he may decide the penalties are too great and move back to the city. Such an individual optimization process can be comparatively rapid (because of the rapid feedback of experience to the individual) so that the statistical pattern of a large social group may be an important "real-time" indicator of societal trade-offs and values.

"Involuntary" activities differ in that the criteria and options are determined not by the individuals affected but by a controlling body. Such control may be in the hands of a government agency, a political entity, a leadership group, an assembly of authorities or "opinion-makers," or a combination of such bodies. Because of the complexity of large societies, only the control group is likely to be fully aware of all the criteria and options involved in their decision process. Further, the time required for the feedback of the empirical experience resulting from the controlling decisions is apt to be very long. The feedback of cumulative individual experiences into societal communication channels (usually political or economic) is a slow process, as is also the process of altering the direction of the control group. We have many examples of such "involuntary" activities, with perhaps war being the most extreme case of the operational separation of the decisionmaking group from those most affected.

In examining the historical benefit-risk relationships for "involuntary" activities, it is important to recognize the perturbing role of public psychological acceptance of risk arising from the influence of authorities or traditional dogma. Because in this situation the decisionmaking is separated from the affected individual, society has generally clothed many of its controlling groups in an almost impenetrable mantle of authoritative wisdom. The public generally assumes that the decisionmaking process is based on a rational social benefit-risk analysis. While it often is, we have all seen disclosed many after-the-fact examples of irrationality. It is therefore important to omit such "witch doctor" situations from the selection of examples of optimized "involuntary" activities—because in fact, they are not as yet optimized, but only in the initial stages of option exploration.

With this description of the problem, and the associated caveats, we are in a position to discuss the quantitative correlations. For the sake of simplicity in this initial study, I have taken as a measure of the physical risk to the individual the fatalities (deaths) associated with each activity. Although it might be useful to include all injuries (which run 100 to 1000 times as many deaths), the difficulty in obtaining data and the unequal significance of varying injuries made it an inconvenient complexity. So the risk measure used here is the statistical probability of fatalities per hour of exposure of the individual to the activity considered. The choice of the "hours exposure" unit was deemed to be more related to the individual's intuitive process in choosing an activity than an "annual" unit, and using the "annual unit" did not appear to change the substance of the results.

The social benefit derived from each activity was converted into a dollar equivalent, as a measure of integrated value to the individual. This is perhaps the most uncertain aspect of the correlations because it reduces the "quality-of-life" benefits of an activity to an overly simplistic measure. Nevertheless, the correlations seemed useful, and no better measure was available. Each activity was evaluated individually, and each detailed approach is described in the appendix. In the case of the "voluntary" activities, the amount of money spent on the activity by the average individual involved was taken as a measure of its benefit to him. In the case of the "involuntary" activities, the contribution of the activity to the individual's annual income (or the equivalent) was taken as a measure of its benefit.

In all cases, the benefits were taken on an annual dollar basis because it seemed to be more appropriate to the individual intuitive process. For example, most voluntary sports require an investment and upkeep only partially dependent on usage—and my sporting colleagues seem very motivated by this situation. The associated risks, of course, exist only during the hours of exposure.

Probably the best example of the analysis of an "involuntary" activity is the benefit and risk associated with the use of electricity. In this case the fatalities included those arising from electrocution and electrically caused fires. The benefits were estimated from a United Nations study of the relationship between energy consumption and national income, and the fraction associated with electric power was used. As compared to the use of electricity in industry, the more subtle contributions of electric power to our quality-of-life are, of course, omitted. For instance, the availability of refrigeration has certainly improved our national health, and the recreational aspect of dining. The electric light has certainly provided great flexibility in living. The contributions of TV may be more uncertain, but the public response indicates that it is a positive element in our living patterns. Perhaps, however, the income measure used is sufficient for the present purpose.

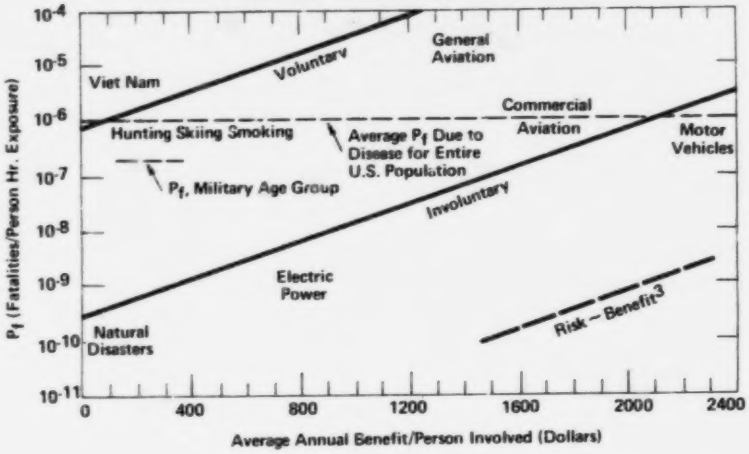
The other societal activities have been studied in a similar manner, as described in the appendix, and the results assembled in fig. 1. For comparison purposes the figure also contains the average risk of death from disease. Several major features of the benefit-risk relations are apparent, the most obvious being the separation by several orders of magnitude between the "voluntary" and "involuntary" societal acceptance of risk. As one would expect, we are loathe to let others do unto us what we happily do to ourselves.

The disease death rate appears to play a yardstick role in determining the acceptability of risk on a voluntary basis. Most sporting activities are surprisingly close to the disease level—almost as though the individual's subconscious computer adjusted his sporting courage to meet but not exceed the statistical mortality due to involuntarily exposure to disease. Perhaps this defines the demarcation between boldness and foolhardiness.

Thus, a generalization may be hypothesized as follows. *The benefit-risk relationship may be optimized for voluntary activities at a risk level not exceeding that due to the average risk from involuntary exposure to disease.*

The Vietnam war statistic was shown because it raises an interesting point. Its risk is only slightly above the average disease risk. Assuming that some long-range societal benefit was anticipated from this war, the related risk as seen by

Figure 1 - Risk Vs. Benefit
Voluntary and Involuntary Exposure



society as a whole is not substantially different from the average non-military disease risk. However, to the exposed military-age group (20–30) the Vietnam risk is about 10 times the normal U.S. disease rate for that age. Hence a difference in perspective.

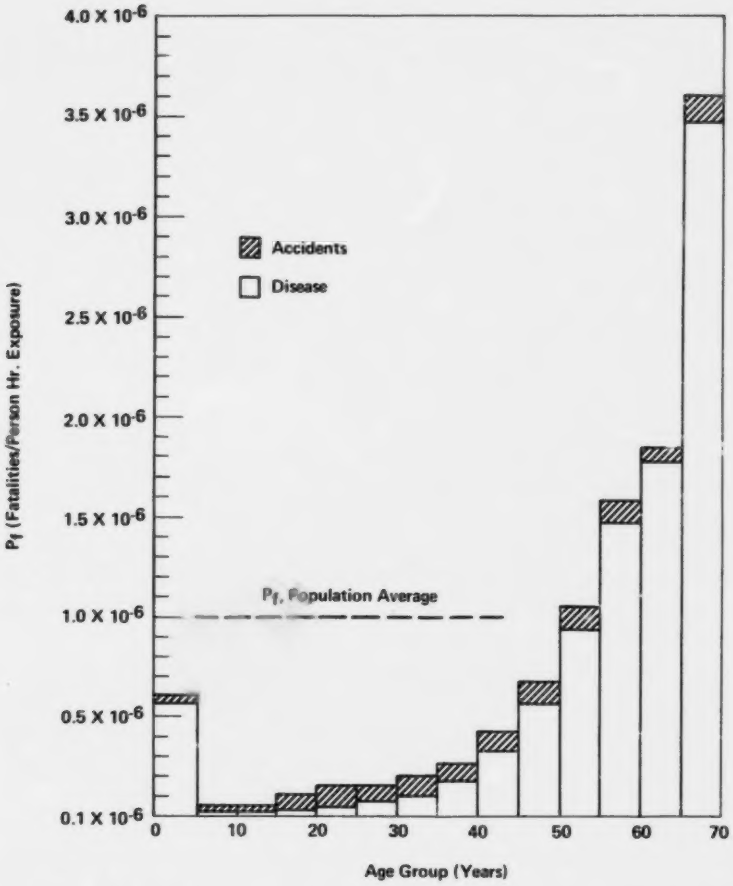
This raises the question as to whether the disease risk pertinent to the age of an involved individual might not make a more meaningful comparison than the national average. As shown in fig. 2, this would complicate these simple comparisons, but it may be more significant as a yardstick.

Returning to fig. 1, the "involuntary" category of activities, all are below the disease risk and seem to fall in a band in which the acceptability of the risk varies as the cube of the benefit. If this relationship has validity, it may mean that three parameters in the "quality-of-life" (perhaps health, essentials, and recreation) are equally influenced by any increase in available resources.

It is interesting that a similar relationship occurs in the special case of miners exposed to high occupational risks. Fig. 3 is a plot of the accident rate and severity rate of mining injuries vs. the hourly wage. The acceptance of individual risk proportional to the cube of the benefit is evident. The significance of this relationship is not obvious.

Returning again to fig. 1, the risk positions of general aviation, commercial aviation, and motor vehicles deserve special comment. Motor vehicles originated as a "voluntary" sport, and have had a half-century to become an essential utility. General aviation is still highly voluntary. Commercial aviation is partly

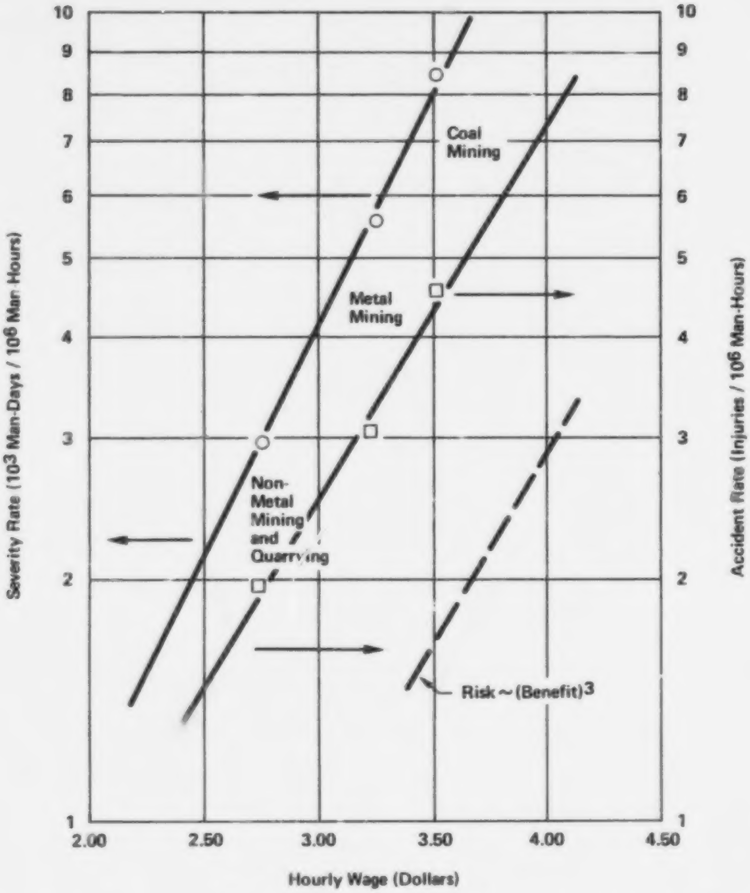
Figure 2 - Risk Vs. Age Group for Accidents and Disease



voluntary and partly essential, and additionally is subject to government administration as a transportation utility.

The motor vehicle has now reached a mature benefit-risk balance, as shown in fig. 4. It is interesting that its present risk level is only slightly below the disease level. In view of the high percentage of the population involved, this probably represents a true societal judgment on the acceptability of risk in relation to

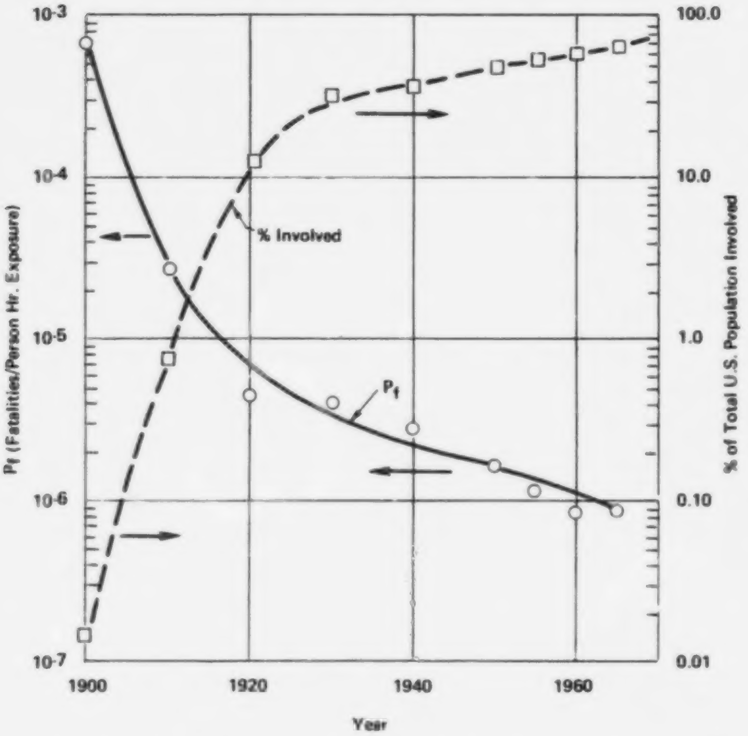
Figure 3 - Mining
Accident Rates Vs. Incentive



benefit. It also appears from fig. 4 that future reductions in the risk level will be slow in coming, even if the historical trend of improvement can be maintained.

Commercial aviation has barely approached a risk level comparable to that set by disease. The trend is similar to that of motor vehicles, as shown in fig. 5. However, the percent of the population participating is now only a twentieth that of motor vehicles. Increased public participation will undoubtedly increase the pressure to reduce the risk, because for the general population the benefits are

Figure 4 - Risk and Participation Trends for Motor Vehicles



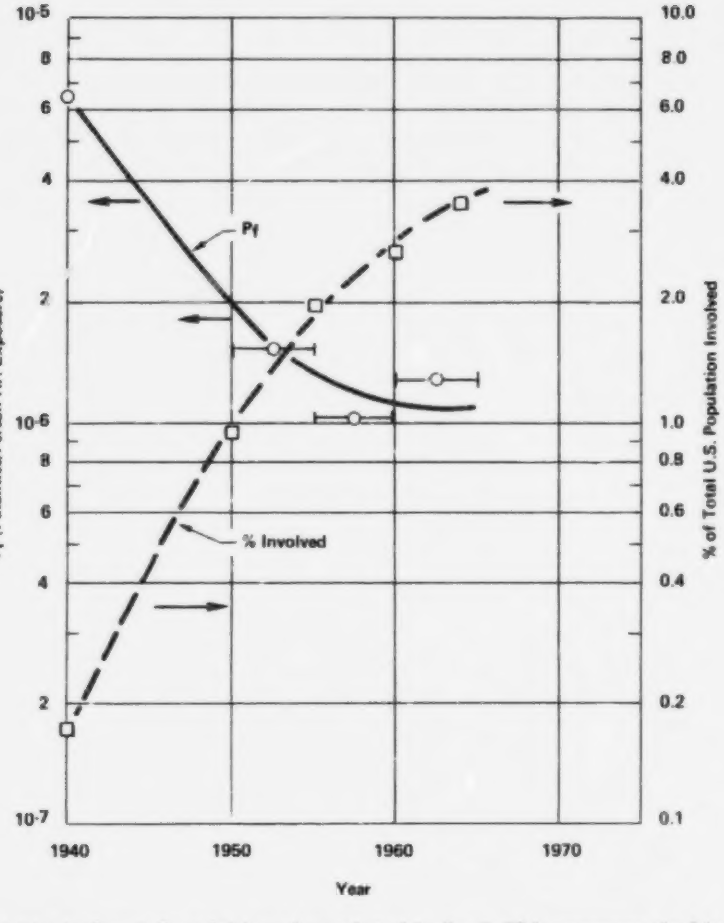
much less than those associated wtih motor vehicles. Commercial aviation has not yet reached a mature optimum of benefit-risk trade-off.

General aviation has similar trends, as shown in fig. 6. Here the risk levels are so high that this activity must properly be considered in the category of an adventuresome sport. However, the rate of decrease of risk is so rapid, that eventually general aviation may approach commercial aviation in performance. The percent of the population involved is so small that the present average risk levels can be considered as acceptable only to a limited group.

The similarity of the trends in figs. 4, 5, and 6 may be the basis for another hypothesis as follows. *The acceptable risk is inversely related to the number of people participating in an activity.*

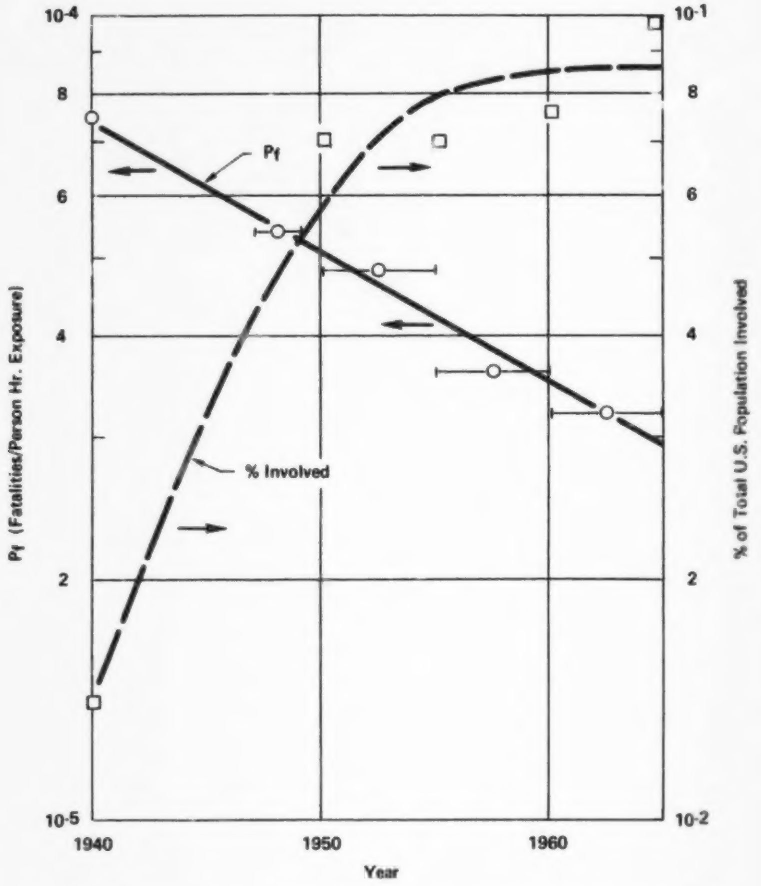
The product of the risk and percent of population involved in each of the

Figure 5 - Risk and Participation Trends for Certified Air Carriers



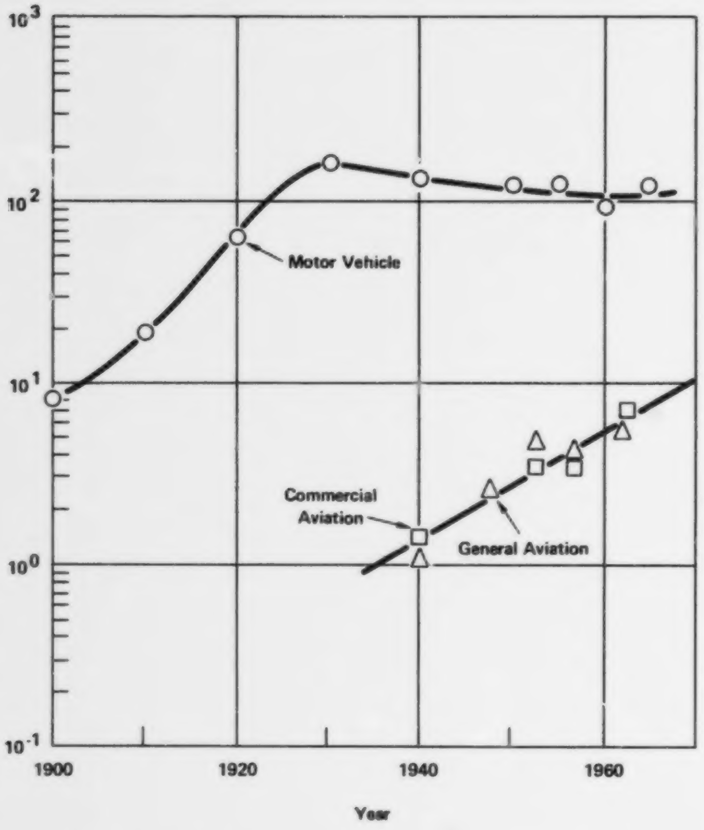
activities in figs. 4, 5, and 6 have been plotted in fig. 7. This represents the historical trend of fatalities per hour of exposure of the population involved. The leveling off of motor vehicle risk at 100 fatalities per hour of exposure of the participating population may be significant. Because most of the U.S. population is involved, this rate of fatalities may have sufficient public visibility to set a level of social acceptability. It is interesting, and disconcerting, that the aviation trend of fatalities, both commercial and general, is uniformly upwards.

Figure 6 - Risk and Participation Trends for General Aviation



As a final attempt to quantitatively probe our societal attitudes, the relationship of this risk data with a crude measure of public awareness of the social benefits was attempted. This is shown in fig. 8. The "benefit awareness" was arbitrarily defined as the product of the relative level of advertising and the percent of population involved in the activity. The calculations are described in the appendix. Perhaps this approach is too crude, but it does support the reasonable position that advertising the virtues of an activtiy increases the public acceptance of a greater level of risk. This, of course, could subtly produce a fictitious benefit-risk ratio—as may be the case for smoking.

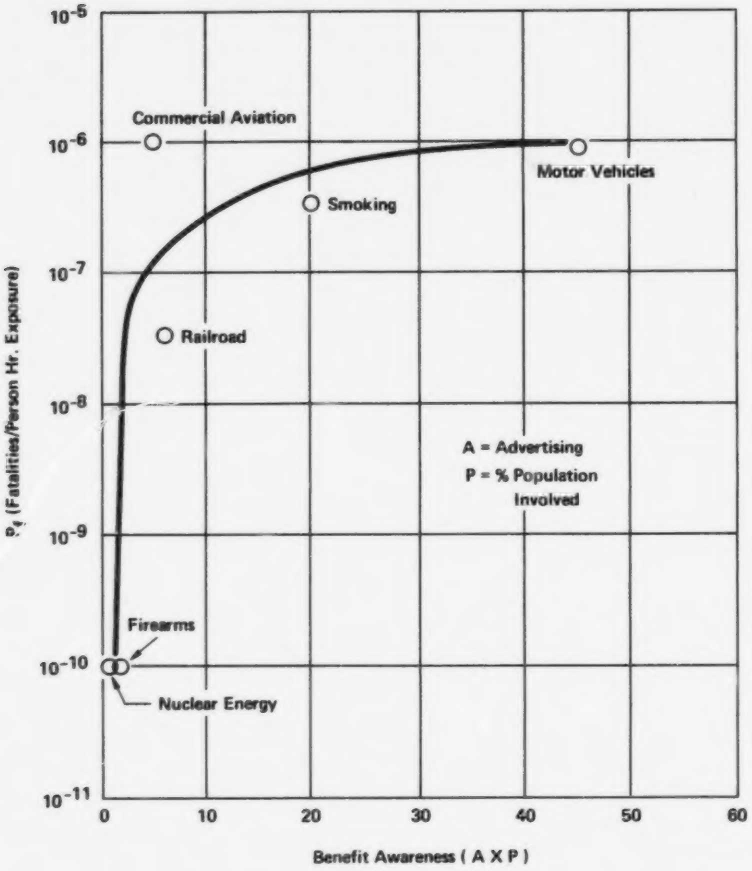
Figure 7 - Group Risk Vs. Year



Recognizing the uncertainty inherent in the quantitative approach discussed in this presentation, the trends and magnitudes may nevertheless be of sufficient validity to warrant their use in determining national "design objectives" for technological activities. How then would this be done?

Let us consider as an example the introduction of nuclear powerplants as a principal source of electric power. This is an especially good example because the technology has been primarily government nurtured, guided, and regulated—with industry undertaking the engineering development and diffusion into public use. The government specifically maintains responsibility for public safety. Further, the engineering of nuclear plants permits continuous reduction of accident probabilities with an associated substantial increase in cost. Thus the trade-off of utility and potential risk can be made quantitatively.

Figure 8 - Accepted Risk Vs. Benefit Awareness



Another feature of the nuclear powerplant is that the empirical approach to achieving an optimum benefit-risk trade-off is not pragmatically feasible. All such plants are now so safe, that it may be 30 to 50 years before meaningful risk experience will be accumulated. By that time, many plants of varied design will be in existence, and the empirical accident data may not be applicable to those being built. So a very real need exists now to establish "design objectives" on a predictive performance basis.

Let us first assume that a nuclear powerplant should be 10 times safer than electric power is generally, so as not to substantially increase public risk. Fig. 1 indicates that the electric power risk is 10^{-9} fatalities per person per hour of exposure. Assuming continuous operation, the nuclear plant would have to achieve a fatality level of not more than 1 death per million population per year (10^{-9} x 10^{-1} x 10^{6} x 10^{4} hrs./yr. = 1). In a modern society a million people may require a million kilowatts of power, and this is about the size of most new power stations. So, we now have a risk limit of 1 death per year per 10^{6} kw power station.

Technical studies of the consequences of hypothetical (and unlikely) nuclear powerplant catastrophes, which would disperse radioactivity into populated areas, have indicated that about 10 lethal cancers per million population might result. On this basis, each such powerplant might statistically have one such accident every 10 years and meet the risk limit set. However, such a catastrophe would completely destroy a major portion of the nuclear section of the plant, and either require complete dismantling or years of costly reconstruction. Because power companies expect plants to last about 30 years, the economic consequences of a catastrophe every 10 years would be completely unacceptable. In fact, the operating companies would not accept one such failure, on a statistical basis, during the normal plant lifetime. It is likely that, in order to meet the economic performance requirements of the companies, a catastrophe rate less than once in about 100 plant-years would be needed. This would be a public risk of 10 deaths per 100 plant-years, or one-tenth death per year per million population. So, the economic investment criteria of the nuclear plant user, the power company, would probably set a risk level one hundred times less than the present risk associated with electric power.

An obvious design question is whether a nuclear powerplant can be engineered with a predicted performance of less than one catastrophic failure in 100 plant-years of operation. I believe the answer to that question is yes, but that is a subject for a different occasion. The principal point is that the issue of public safety can be focused on a tangible, quantitative, engineering design objective.

The application of this approach to other areas of government responsibility is self-evident. It does provide a useful answer to the question "how safe is safe enough?"

Some Problems in Economic Analysis of Environmental Policy Choices

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Synopsis

WITH RESPECT to social programs, economics is concerned with developing a framework for understanding the relative costs and gains for alternative allocations of scarce resources. Economics can be described as a science of choice in a society where resources for pollution abatement compete with those for other social purposes. Economics is also concerned with analyzing our system of producing and consuming commodities and services, which are the processes which give rise to waste products and hazardous commodities.

Environmental policy actions by community or government are attempts to substitute for the market as a control device. Cost-benefit analysis is suggested and discussed as one tool for evaluating and selecting policies and strategies of control. Two levels of

problems—illustrated with economic data and cost curves—involve: (1) How to achieve the lowest cost for any given level of effect, or the greatest effect for any given cost, and (2) how to maximize the benefits minus cost for the greatest total good. In the case of air and water pollution, data suggest that much can be gained at rather modest costs. A variety of applications of cost data is presented.

The political, social, economic, and engineering analysis required for appropriate program coordination and policy selection is a large order and demands a sophisticated understanding of interdependencies. It is hoped that as advances are made in human ecology, its sister field of economics will be considered as neither irrelevant or fully developed.

INCREASINGLY in recent years, scientists, scholars, and managers of private and public enterprises have been recognizing the importance of understanding interdependencies. It has emerged in the biosciences as ecology, in sociology as human ecology, in philosophy as organicism (*1*), in public health as comprehensive health planning (*2*), in communications and other technological applications as systems engineering, and in management decisionmaking as systems analysis. Definitions are numerous and overlapping, but a common thread is the importance of interactions and interdependencies, not only among system components, but also with system environments.

Formal similarities among these fields have been noted, even between economics and ecology (*3*). This should augur well for communication amongst our professions. I certainly hope so, for this morning I will discuss a few aspects of economics which relate to environmental control. My object is make some pedestrian, but hopefully useful, remarks on approaches for improving our selection from among possible policies.

Economics can be described as a science of choice. With respect to social programs, it is concerned with developing a framework for understanding the relative costs and gains for alternative allocations of scarce resources. If our resources were not scarce, there would be no economic problem. But time, human effort, natural resources, and even money are limited, so that expending resources for one set of purposes will leave us less for others. This is what economists mean by "cost"—that which we give up because we choose a particular course of action. Our apparent pennypinching materialist outlook results from continual search for the answer to the question—Could we do better if we spent our resources somewhat differently? As a consequence, much of our time is spent figuring out how to measure the consequences of actions—costs and benefits.

Economics is also concerned with analyzing our system of producing and distributing commodities and services. It is these processes which give rise to waste products and hazardous commodities. The market is not the only determinant of what is received by consumers or what is used as inputs in business firms. There are some goods and services which come to the consumer or business whether he wants them or not and without his paying for them or being able to avoid them by making a payment. An economic unit may generate effects that are "external" to it. Among the clearest and most important sources of such externalities are the waste residuals resulting from production processes and consumption activities. A society which relies completely on a decentralized decisionmaking system and in which significant externalities (environmental overloadings) occur, as they do in any society which contains significant concentrations of population and economic activity will find that certain resources are not used optimally. Obviously the complete elimination of waste products would be too costly. But if no price or other restriction is put upon the assimilative capacity of the environment, it will be abused, and external costs appear such as the death of fish, restrictions on swimming, increasing costs of water treatment, health, property, and plant damage from air pollution, health and social effects of inadequate solid waste disposal (*4*).

Environmental policy actions by community or government are attempts to substitute for the market as a control device. But how can we assure that preferable policies are designed and selected?

Cost-benefit analysis is one way of evaluating possible policies such as subsidies, taxes, standards, or resource management actions. Conceptually we have two levels of problems. First, how to achieve the lowest cost for any given level of effect, or the greatest effect for any given cost; second, how to maximize the benefits minus cost for the greatest total good.

Assuming that we know the minimum costs of achieving various levels of pollution abatement, and that we know the benefits of such policies (or the costs of damage without such), we could construct charts such as figures 1 or 2 to determine what level of abatement activity was preferred (*5*).

An understanding of the general implications of such curves leads to the conclusion that more abatement is not always to be preferred. The question of how much is very relevant, as additional costs may at some point outweigh additional benefits. The diagrams may remind us to ask not what the average costs and benefits are, but rather what the implications are at the margin.

The ability to plot specific curves as these depends on our capacity to measure costs and damages and to measure them in the same dimension—dollars. While various estimates have been made of some effects of environmental conditions, even where we think we know health effects, we are as yet far from agreement as to how or even whether to measure these in dollars.

But while this may limit the determination of the optimal scale of abatement operations, we can still relate different levels of human exposure to pollutants to the costs of achieving these.

Recent studies of air pollution have developed simulation techniques that could be used by Federal, State, and local governments or for public and private research groups which provide a rapid means of evaluating the cost-performance advantages of competing techniques for emission control based on the specific abatement objectives being pursued in an area (*6*). These studies improved our knowledge of the factors which have a significant impact on both the choice of abatement methods and the cost to achieve specified levels of abatement—

- variations in meteorological conditions, such as wind direction and speed, frequency of calm and windy days, and temperature inversions;
- location of emitters, such as upwind of the central city;

Figure 1

Cost to Society from Air-Pollution Damage
Cost to Society for Air-Pollution Control

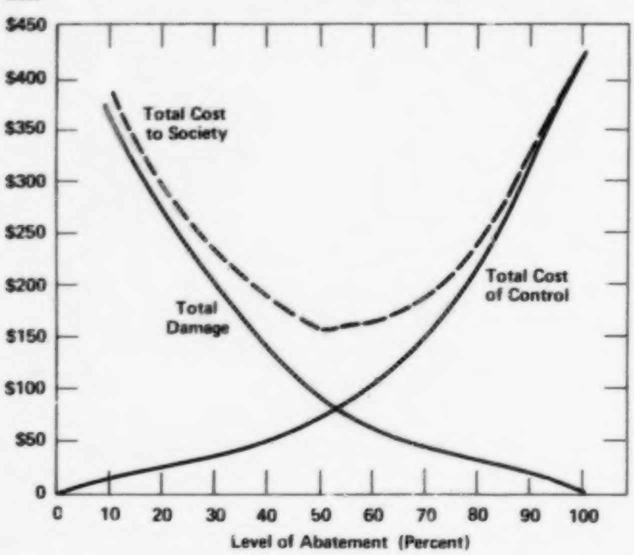


Figure 2

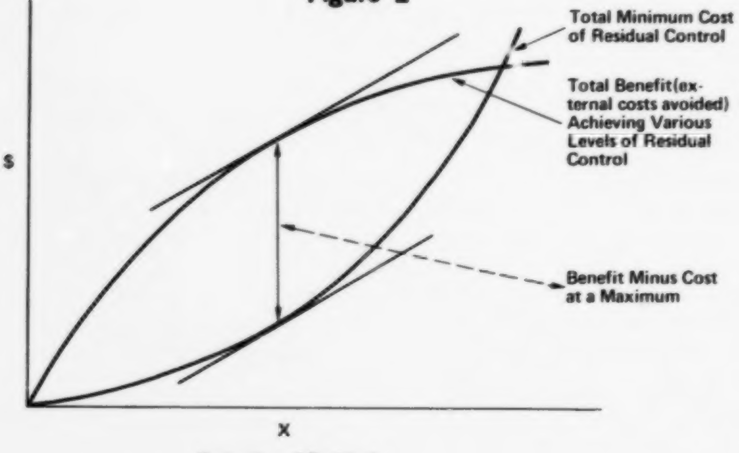
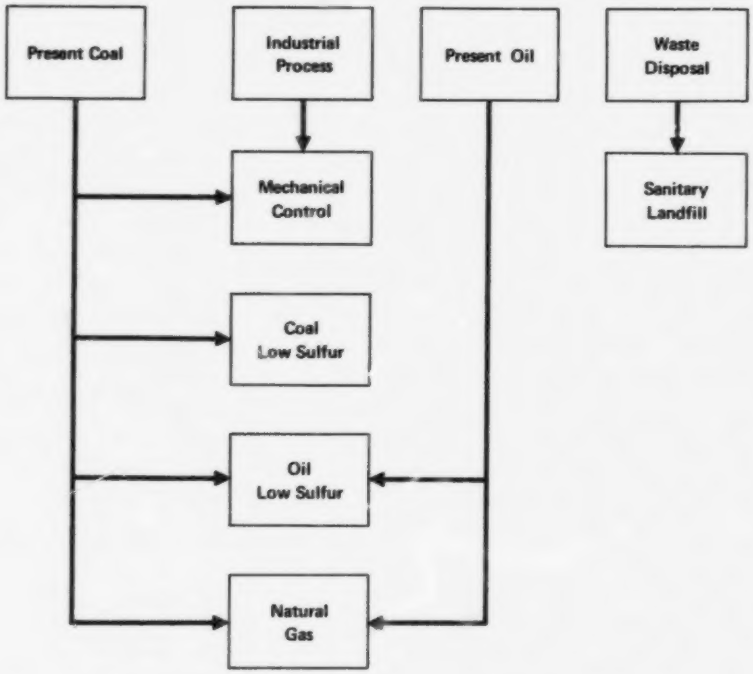


Figure 3 - Alternatives For Particulate and Sulfur Oxides Emission Control (Stationary Sources)



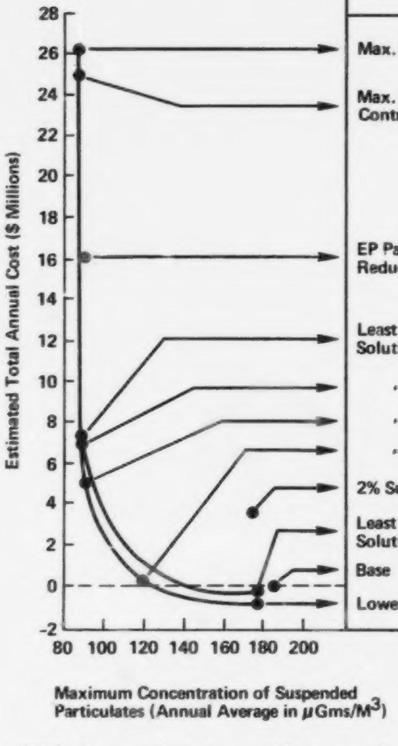
- location of potential receptors, such as dense population centers; and
- prospects for technological change, such as desulphurization of coal.

With optimal choice depending on these factors, some of the alternative methods for abatement were examined and costed such as—

- pretreatment of inputs, such as desulphurization of oil;
- improvements in the processes that create harmful wastes, such as improved combustion;
- treatment of waste once generated, such as scrubbing and bagging; and
- further dilution of wastes, such as higher smokestacks.

Failure to consider all or any of these factors or methods can cause cost estimates to be excessively high and may cause the government to provide incentives for more costly methods.

Figure 4 - Comparison of Simulated Abatement Strategies For Kansas City Study Area



Strategy	Maximum Concentration		% Emission Reduction	
	μGms/M^3	ppm	Partic.	SO_x
Max. Control	85	0.015	69	81
Max. Partic. Control	85	0.038	69	48
EP Partic. Reduc. ≥ 20%	89	0.035	59	13
Least Cost Solution	86	0.023	66	42
"	86	0.040	68	7
"	89	0.040	68	7
"	120	0.040	59	7
2% Sulfur Fuels	175	0.035	10	38
Least Cost Solution	177	0.023	5	40
Base	184	0.046	0	0
Lowest Cost	177	0.040	5	5

With these tools it is possible to search out preferred strategies and policies. Simulation studies done by Ernst & Ernst for the Kansas City area show some of these possibilities (7). This study considered a number of alternatives (see fig. 3), but did not consider nuclear fuels or high stacks. The vertical axis on figure 4 is estimated annual cost in millions of dollars; the horizontal axis is the predicted maximum annual average concentration of suspended particulates at any point in the Kansas City study area. The topmost point in this figure locates maximum control strategy. The bottommost point locates lowest cost strategy.

The vertical axis on figure 4 shows the estimated annual cost in millions of dollars; the horizontal axis measures the predicted maximum annual average concentration of suspended particulates at any point in the Kansas City study area. The curve connecting the maximum control strategy to the lowest cost contains all of the least-cost solutions for reducing the maximum concentration of suspended particulates without deliberately controlling sulphur oxides. The curve which merges with it connects all the least-cost strategies for reducing the maximum concentration of suspended particulates while requiring that the initial maximum concentration of sulphur oxides, 0.046 p.p.m., be reduced by half to 0.023 p.p.m. A least-cost solution is defined as that combination of emission controls which achieves a stated objective for the least total annual cost to the whole community. Reduction to 89 micrograms per cubic meter from 120 can be achieved for an estimated cost of $5 million annually with a 59-percent reduction in emissions. Reduction to 86 grams per cubic meter can be achieved with a 68-percent reduction in emissions for about $7 million with a bonus reduction of the maximum concentration of sulphur oxides to 0.040 p.p.m. For another $½ million annually the maximum sulphur oxides concentration can be reduced to 0.023 p.p.m. with a 42-percent decrease in emissions. Comparing these least-cost solutions to the maximum provides a rather dramatic example of diminishing returns.

Cost-effectiveness and cost-benefit studies are one tool in the selection of preferred policies or strategies. But whether the best strategy could be acceptable depends on the total bill, as resources for pollution abatement compete with those for other social purposes. Again, if the outputs of our programs were in commensurable terms such as dollars, it would simply require a comparison of costs and benefits with that mix of programs yielding the highest return of benefits over costs (as in fig. 1) would be selected. But programs do not have such neatly categorizable outputs, so the best we can do is to discuss what we might get for our money, and how much that money is. In the case of both air and water pollution, much appears possible at rather modest costs. The Federal Coordinating Committee on the Economic Impact of Pollution Abatement using an extrapolation of the simulation approach, has estimated that the additional annual cost of efficiently reducing human SO_X and particulate exposure by 60–75 percent from the present level in all metropolitan areas at about three-quarters of a billion dollars (*8*) (fig. 5).

The annual additional cost of providing the equivalent of 85 percent treatment of biochemical oxygen demanding material and suspended solids was estimated at less than $1 billion (see fig. 6).

Dollar estimates of air pollution damage run about $10 billion per year for sickness and resulting absence from work, property damage, plant damage, and aesthetic loss. It has been estimated that an air pollution program costing about half a billion per year might reduce that damage by about half—a benefit of $5 billion per year, or an average benefit-cost ratio of about 10 to 1. While compari-

FIGURE 5.—Annual Cost[a] of Achieving a Hypothetical Standard by Reducing Human Exposure of Sulphur Oxides and Particulates by 60–75 percent in a "Typical City" of 2 Million People and Extrapolated for the United States, 1967

[Millions of dollars]

	Typical city		United States[d]	
	Least cost[b]	Proportional reduction[c]	Least cost	Proportional reduction
Capital cost	$1.17	$2.29	$81.90	$160.30
Operations and maintenance	9.81	15.78	686.70	1,104.60
Total	10.98	18.07	768.60	1,264.90
Cost to industry[e]	$5.05	$8.31	$353.56	$581.85
Percent of value added	....	....	.16	.26
Cost to others[f]	$5.93	$9.76	$415.04	$683.05
Per capita	....	....	$2.96	[h] $4.88
Percent of per capita income[g]	....	....	.11	.18

[a] Includes cost from substituting fuels, purchasing more costly lower sulphur-content fuel, and treatment of emissions whichever is cheaper for each emitter.

[b] Only those discharging harmful waste loads and technically able to reduce waste-loads were required to abate in the simulation.

[c] All waste-load emitters must reduce waste discharges by the same proportion.

[d] Assumed same air quality conditions hold for all standard metropolitan statistical areas—70 percent of the Nation's population of 200 million.

[e] All manufacturing, incinerators, and electric power companies if abatement costs were allocated as a proportion of waste-loads emitted.

[f] Almost entirely for space heating.

[g] Per capita disposable income for the entire country was $2,735 in 1967.

[h] In dollars—e.g., $2.96 and $4.88.

Source: Data from National Center for Air Pollution Control's "Typical" city study and the Commerce Department.

FIGURE 6.—Estimate of Additional Annual Cost of Water Pollution Abatement to Meet a Hypothetical Industrial Water Quality Standard Requiring 85 Percent Removal of Biochemical Oxygen Demanding Wastes and Suspended Solids

[Millions of dollars]

	Current annual cost (1966)[a] (1)	Additional annual cost (2)	New annual cost—add cols. (1) and (2) (3)	Percent of total annual cost (4)
Capital costs:[b]				
Manufacturing waste-treatment facilities	$172	[c] $74	$246	27
Portion of municipal facilities used by manufacturers	47	20	67	7
Total	219	94	313	34
Operation and maintenance costs:				
Manufacturing waste-treatment facilities	380	163	543	59
Portion of municipal facilities used by manufacturers	43	18	61	7
Total	423	181	604	66
Total cost	642	275	917	100
Average burden on manufacturing firms:				
Percent of total value added by manufacturing in 1966 ($218.6 billion)	.294	.126	.420	....

[a] See table IV.

[b] Amortized over 20 years at 6 percent interest for industry and over 25 years at 4½ percent for municipalities.

[c] Assuming the same proportional use of municipal facilities and that manufacturers actually pay fees adequate to cover capital costs.

Source: Data from Federal Water Pollution Control Administration and Commerce.

FIGURE 7.—Soft Coal Production and Employment in Principal Producing States in 1964, by Sulfur Content

	1 percent or less sulfur		Over 1 percent sulfur	
	Production (million) short tons	Employment	Production (million) short tons	Employment
Alabama	8.9	3,360	5.6	2,061
Colorado	4.4	1,713		
Illinois			55.0	8,172
Indiana	(a)	(a)	15.0	2,542
Kentucky—eastern	40.4	15,631	4.5	2,408
Kentucky—western			37.9	4,551
Missouri			3.3	466
New Mexico	3.0	307		
North Dakota (lignite)	2.6	208		
Ohio			37.3	8,421
Pennsylvania			76.5	23,349
Tennessee	1.5	656	4.5	2,376
Utah	4.7	1,653	(a)	(a)
Virginia	26.0	7,579	5.6	1,779
West Virginia	89.0	26,377	52.4	12,931
Wyoming	3.1	401		
Total United States (including all other States)	185.4	58,479	301.6	70,219

[a] Negligible.

Source: Bureau of Mines.

sons are tricky, to give you a feel for this relative to some other programs, vocational rehabilitation has been estimated to have payoffs of 16 to 1, while the Job Corps has one of about 1½ to 1(*9*).

We are concerned with the costs of environmental pollution control not only for determining total costs and benefits, but also as a guide to its impact on industry and the appropriate ways of allocating costs. The Federal Coordinating Committee's rough estimates of the average additional annual cost caused by higher levels of pollution abatement was that it was relatively small, and therefore did not call for any plan of assistance in the form of tax writeoffs or grants and loans for industry. It did recommend some assistance for individual hardship cases (*10*).

Economic analyses of the costs of environmental improvement for health are needed for policy guidance in safety as well as pollution. The development of the Federal Radiation Council standards for uranium mines is an example. The impact of raising standards on production costs of yellow-cake and electric power have only recently been explored (*11*).

Costs of pollution control programs are not limited to government expenditures and changes in industry processing costs alone. There may be serious implications on employment, such as of miners of bituminous coal. Figure 7 shows the distribution of miners by State and by sulphur content of coal for 1964. Coal containing more than 1 percent sulphur accounted for 55 percent of employment, and even more significant, is that all of the coal produced in Pennsylvania, Ohio, Illinois, Indiana, and western Kentucky was high sulphur. These areas produced 212 million tons and employed 47,000 workers (*12*).

For many programs social costs, the externalities we mentioned earlier, are very difficult to identify and measure. Currently the Northeast Corridor Project of the Department of Transportation is trying to develop methods for ascertaining the costs of the noise which its high-speed trains will occasion on those who live within hearing distance. Recently a study done for the Department of Housing and Urban Development in the area of urban transport made an attempt to measure not only user costs and benefits, but other costs such as accidents and air pollution (*13*). Figure 8 is a copy of one of their printouts which illustrates the kinds of measures used.

The urban transport study is an example of the complexities of program planning. While the Department of Housing and Urban Development is planning transport systems which may increase or decrease the volume of environmental pollution and have some effects on access to jobs and cultural activities by the disadvantaged, programs with similar goals or affecting these dimensions of society are being developed by the Departments of Health, Education, and Welfare; Transportation; Labor; and the Office of Economic Opportunity; to say nothing of local public and private organizations. The political, social, economic, and engineering analysis required to gain sufficient insight for appropriate program coordination and policy selection is a large order, far more demanding of an understanding of interdependencies than the calculations in the various examples illustrated by the figures in this paper.

These scattered examples have been intended to illustrate the importance of economic considerations in selecting environmental policies; and to indicate that these concepts and measurements are useful and feasible. They aren't easy to develop, and much difficult research needs to be done. The state of the art of economic analysis needs to be improved for social planning purposes. I hope that as plans are formulated to press forward in the field of human ecology its sister field of economics will be considered as neither irrelevant nor already fully developed.

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Summary of Discussion Following Papers by Dr. Starr and Dr. Grosse

The discussion was initiated with a statement that the definition of human ecology used to that point in the Symposium had been too narrow. It was pointed out through an example that the effects of man's environmental interactions are interwoven throughout the total ecological system.

Discussion turned to Dr. Starr's statement that technological innovations are broadly applied before the social impact of the innovation can be determined. It was suggested that CPEHS should establish advisory groups to evaluate new technological developments and anticipate adverse environmental effects. In this connection, it was pointed out that Government may have to set standards in areas where industry cannot exercise voluntary control because of the risk of competitive disadvantage.

The application of economic analysis techniques such as cost-benefit analysis to environmental problems was discussed at length. Concern was expressed that the use of such techniques required the establishment of average values for risk, benefit, cost, etc., and that in determining the average values, the special problems of certain segments of society are likely to be overlooked. In defense of the use of economic analysis it was recognized that such techniques must be applied with a thorough understanding of all factors involved and that through such understanding valuable indicators of priorities can be developed.

FIGURE 8.—Mun 219 Houston 80 O/D With 200 MI GWY Cost-Benefit Ledger

[Summary of preliminary cost-benefit measures]

	Units	Total		Public		Private			
Dollar cost									
Overall cost:									
Total cost	M$/yr	828		110		718			
Initial	M$	1,762		619		1,142			
Recurring	M$/yr	715		70		645			
Unit Cost:									
Actual Trip	$/trvlr-mi	0.079		0.068		0.081			
Potential Trip	$/trvlr-mi	0.024		0.011		0.030			
Actual vehicle Flow	$/veh-mi	0.099		0.047		0.119			
User cost-benefit		24 hours			Peak hour			Off-peak hour	
		Total	Public	Private	Total	Public	Private	Total	Public	Private
Trip Distribution	Percent	100.0	21.3	78.7	100.0	21.6	78.4	100.0	21.1	78.9
Distance traveled	M-mi	39.7	5.9	33.8	3.8	0.6	3.2	2.3	0.3	2.0
Average trip time	Minutes	11.8	11.9	11.8	14.3	11.9	15.0	10.4	11.9	10.0
Airline speed	Mph	30.78	21.02	33.43	24.81	22.35	25.33	35.47	20.25	40.29
Accommodation	Percent seated	100.0	99.9	100.0	100.0	99.8	100.0	100.0	99.9	100.0
Inconvenience:										
Excess time	Min/trvlr	2.8	5.9	2.0	2.7	5.0	2.0	2.9	3.4	2.0
Outdoor time	Min/trvlr	1.5	3.7	0.9	1.5	3.2	1.0	1.6	4.0	0.9
Congestion time	Min/trvlr	1.7	0.3	2.0	3.5	0.7	4.2	0.6	0.1	0.8
Exertion:										
Walking distance	Mi/trip	0.0750	0.1794	0.0468	0.0748	0.1684	0.0490	0.0752	0.1858	0.0455
Driving distance	Mi/trip	3.91	0.00	4.97	4.93	0.00	6.29	3.33	0.00	4.22
Privacy index	Veh/trvlr	0.749	0.881	0.731	0.864	0.822	0.870	0.651	0.925	[illegible]

Social cost-benefit		Total	Total Public	Total Private	Central		Urban		Suburban	
					Public	Private	Public	Private	Public	Private
Safety hazards:										
Fatalities	/m-trvlr-mi	0.0122	0.0000	0.0148	0.0000	0.0144	0.0000	0.0141	0.0060	0.0914
Injuries	/m-trvlr-mi	1.6163	0.0015	1.9614	0.0000	1.8935	0.0020	1.8414	0.0013	2.0501
Property damage	/m-trvlr-mi	8.6608	0.0123	10.5092	0.0000	10.1293	0.0159	9.8260	0.0101	11.9478
Space requirement D:										
Exclusive R.O.W	Sq mi/sq mi	0.02372	0.00000	0.02372	0.00000	0.14096	0.00000	0.04782	0.00000	0.81925
Buildings	Sq mi/sq mi	0.00413	0.00113	0.00300	0.00000	0.17227	0.00316	0.01785	0.80078	0.89080
Intrusion	Veh-mi/sq mi/hr	1,664	4	1,660	284	19,036	19	4,483	0	1,127
Pollution:										
Carbon monoxide	Lb/day/sq mi	2,969	1	2,968	44	32,655	3	8,461	8	1,942
Nitrogen oxides	Lb/day/sq mi	307	1	306	44	3,366	3	872	0	200
		Total		Central		Urban		Suburban		
Service to disadvantaged:										
Poor: Nearby jobs	Jobs	406,584		90,379		204,150		111,755		
Aged: Other dests	Dests	99,035		12,838		55,358		30,840		
Zone 71:										
Nearby jobs	Jobs	369,087		122,139		220,246		26,702		
Other dests	Dests	397		0		397		0		
Zone 36:										
Nearby jobs	Jobs	672,460		122,139		318,461		231,860		
Other dests	Dests	171,574		20,131		101,785		49,658		
Choice index	Pub/pri time	1.8		0.7		1.4		2.5		
		Peak hour				Off-peak hour				
		Public		Private		Public		Private		
Accessibility to special zones:										
CBD zone, zone 05	People	1,173,400		368,600		1,183,300		838,800		
University, zone 37	People	888,800		472,200		448,500		1,193,000		
Airport, zone 176	People	613,100		357,300		518,000		644,300		
Hospital, zone 86	People	777,200		569,400		447,900		1,052,300		

Centers of Excellence for the Study of Human Ecology

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(Presented by Dr. Frederick Sargent, II)

Synopsis

A GENERAL PLAN for the development of the study of human ecology in the United States and Canada is outlined. Organization and interrelationships within and among universities and research centers are emphasized. A major effort in research and education in man-environment relationships is seen as imperative, because the stress of human occupancy upon the biosphere has reached a critical stage. Problems and opportunities of extradepartmental structuring and of interuniversity cooperation, necessary for optimal use of academic resources, are explored as well as the relationship between ecology and human ecology and other selected disciplines.

Before any such centers project for the environment can be successfully attempted, coherence of purpose is needed. A symposium on the dimensions of human ecology is proposed as one technique for achieving greater coherence of purpose.

The centers of excellence concept is discussed in terms of the contribution that such centers could make to a nationwide ecological effort; the structuring, possible number, and location of centers; and implications of development grants for investigators and for fields of study. The functions of a review committee are explored in some detail. Conjectures are offered on the Federal base for a centers program.

Emphasis is placed on the practical relevance of the centers' contribution: although they should contribute to theory and draw upon it, their mission is the marshaling of verified knowledge for action.

Preface

1. This paper[1] is prepared for the purpose of stimulating and focusing discussion on the development of human ecology as a field of learning. It does not attempt to report the present state of the field; and it cannot analyze problems of research and teaching in depth. Instead, it outlines a general plan for the development of the study of human ecology in the United States and Canada. Emphasis is upon organization and interrelationships within and among universities and research centers. The argument is premised on the belief that a major effort in research and education in man-environment relationships has become imperative. It is imperative because the stress of human occupancy upon the biosphere of the earth has reached a critical stage. Although Americans may not be prepared to make the effort, a "Manhattan Project" for human ecology is as greatly needed now as any military preparation ever was.

Nature and Scope of Human Ecology

2. The term "human ecology" presents difficulties of concept and definition. It sometimes appears to be a subdivision of sociology, it has been closely related to biomedical and health sciences, and it has been treated as a field of interdisciplinary study. Organized in different ways in different colleges and universities, human ecology does not appear to have been conceived as a distinctive, integrated discipline.

3. Human ecology has not yet significantly penetrated secondary or elementary education. Its substance receives some attention in courses in geography, conservation of natural resources, and biology. But ecological concepts have not permeated popular education as they must if sound and timely public policies for the human environment are to be adopted and administered. Unfortunately the secondary schools cannot be expected to offer an adequate education for ecological literacy until the colleges and universities have clarified the concepts and developed the materials for instruction, and have trained more teachers and administrators with an informed awareness of man's ecological relationships.

4. Our focus of concern is therefore at the university level of education. Not all research in human ecology takes place in universities, but the broad scope and complex nature of its subject matter requires the rich multidisciplinary mix that only universities can provide. Centers of excellence in research or teaching must be university related, although not all of them must necessarily be incorporated within the structure of universities. The multidisciplinary nature of the data of

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[1] The author wishes to acknowledge the suggestions and comments of Professor Frederick Sargent II, Dean of the College of Environmental Sciences, University of Wisconsin-Green Bay, in the preparation of this paper.

human ecology is a principal reason for difficulty in its definition, and it affects the academic organization of its study in the following two ways. First, human ecology requires some form of extradepartmental or interdisciplinary structuring. Second, its broad scope and complexity suggest interuniversity cooperation, if optimal use is to be made of academic resources. Each of these aspects of academic organization deserves more detailed comment.

5. In the future, ecology, or human ecology, may emerge as a distinct learned discipline. It may also afford much of the substance of a professional field of applied ecology or environmental management. There are present indications that both of these developments may be possible, but only random experiments have been undertaken thus far. Interdisciplinary studies are seldom popular with the disciplines, but to establish a new discipline in the academic world requires time and travail, reinforced by high-level administrative and financial support. Since there has not appeared to be an obviously "right" way to organize the study of human ecology, arrangements vary from university to university—making interuniversity cooperation more difficult than it might be if academic organizations were comparable. Yet, although there may not be "one best way" to structure the study of human ecology, some ways are better than others. The identification of "better ways" should be a consideration in any effort to develop centers of excellence.

6. Comparability in organization should not imply a sameness of structure or identity of substance. Effective interuniversity cooperation in any field of study requires a degree of congurity or complementarity sufficient to permit communication to be meaningful. But the value of interuniversity cooperation lies in the varied and contrasting emphasis given to ecological studies in different universities. Interuniversity cooperation in human ecology is needed for the very reason that each university can develop particular areas of excellence, but none are likely to excel in everything. Not all universities have schools of engineering, medicine, or law. Not all offer opportunity for the study of agriculture, architecture, mining, forestry, or environmental planning. Yet each of these fields is in some way related to human ecology and there are many others more specialized and less common that have ecological significance. Among them are atmospheric and marine science, biotechnology, general systems theory, and cybernetics. There is thus a wide range of possibility for interdisciplinary and interuniversity involvement in the study of human ecology. It should be possible to identify the basic or nuclear questions of human ecology with which all centers of excellence would be concerned and to obtain a variety of interdisciplinary combinations that would enlarge the possibilities for the advancement of knowledge in the field.

7. A fundamental methodological question concerning the nature and scope of human ecology is its relationship to ecology as a general area of inquiry. The

case for ecology as a discipline seems to me to be stronger than for human ecology. If ecology is perceived as a general science concerned with the systematic interrelatedness of living things in relation to their physical environments, then human ecology appears to be a specialized focus within a larger field of inquiry. If ecology is defined as the study of the organization of the biosphere, human ecology might be described as the study of man's interactions with the biosphere. Man-environment interactions are, of course, of concern to other disciplines but from other perspectives. For example, the affinities of ecology and economics have been widely noted. There are many interactions and transactions common in principle to both disciplines, but manifested in differing ways. Both human ecology and economics are man-centered. In gaining a sharpness of focus and apparent relevance by a concentration upon human behavior, they may hazard the larger relevance that can be obtained by observing man in the larger context of nature.

8. Human ecology seeks to understand man and his problems by studying individuals and populations as biological entities profoundly modified by human society and culture and by studying the effects of physical, biological, and cultural environments upon man and those of man upon his environments. The viewpoint of ecology is at once statistical and typological. The observational reality is always a set of tolerances pertinent to the physics and chemistry of an individual's metabolism and behavior and to those of his behavioral products. Yet this reality persists only through genetic and social mechanisms that transcend individual life sequences to provide the continuities, feedback stabilities, and progressive adaptations of biological and cultural evolution.

9. Which of the following is the more promising organizing concept? Is it the phenomenon of man viewed ecologically, or is it the study of natural systems with special reference to man? Is it more profitable to proceed directly to the particular (man) with such reference to the general as may seem necessary, or would it be more realistic to pace the study of human ecology to move generally with the advancement of general ecology and the sciences of natural systems? These questions may seem abstract, but they are fundamental to a discussion of centers of excellence. Answered one way, they lead toward one set of conclusions about organizing the study of human ecology; answered another way they lead toward differing conclusions. Unfortunately we cannot be sure which route is best. But fortunately as long as there are many investigators both routes may be followed.

10. But we cannot avoid our conceptual difficulties so easily. When the idea of "centers of excellence" is introduced, the question, "Excellence for what?" arises. A major national effort to augment resources and upgrade facilities for the study of man-environment relationships would require a clearer definition of purpose and content than has yet been provided by ecologists. If funds for the study of human ecology were to be provided, criteria for their disbursement

would become necessary. This need for criteria would be even greater if centers of excellence were the means chosen to advance our understanding of human ecology.

11. A comprehensive and critical survey of the present state of the science of ecology in relation to man is obviously needed. A symposium on the dimensions of human ecology has been proposed by the Committee on Human Ecology of the Ecological Society of America. A satisfactory format and the funding for the symposium have yet to be worked out, but ultimately the objectives of this effort must be met in one way or another. Although the field of inquiry is broad, complex, and of indeterminate boundaries, greater and more widely accepted coherence of purpose is needed before any "Manhattan Project" for the human environment can be successfully attempted. To attain this coherence is a necessary first step toward the development of a nationwide ecological effort and it should be one of the major objecitves in any program to develop centers of excellence.

The Centers of Excellence Concept

12. The contribution of centers of excellence to a nationwide ecological effort would be to provide, *first*, centers of strength in which knowledge would develop more rapidly than otherwise, and *second*, centers of influence from which assistance could be made available to educational institutions generally, to civic groups and to governments. Would a "center" be an entire university, or would it denote a special institution or program within a university? Would it apply to autonomous research institutions such as the projected National Institute of Ecology? All of these applications of the center idea are possible, but some special structuring within universities would seem necessary to make effective the interdisciplinary involvement that the study of human ecology requires.

13. Therefore, within the context of this paper, "center" will imply a formalized institution or program. It may be assumed that most "centers" would be developed in large universities, but regional research institutes such as those proposed by the Ecological Society of America would also fall within the "center" concept. Because these regional centers would have close relationships with universities and would probably be established by university consortia, their inclusion in the centers of excellence program is not an exception to the general assumption that they would be essentially academic in character.

14. It would be arbitrary to say how many centers should be established. Several determining factors are conjectural. If the National Institute of Ecology proposal were associated with a centers of excellence program, the geographical location of the institute research centers would be a pertinent factor in the decision. Another uncertain factor would be the relationship of the centers of excellence to urban or regional affairs programs and to the environmental health science institutes already funded by the Public Health Service. Some of these

institutes could probably qualify as centers of excellence, but others may have specialized in technical or biomedical aspects of environmental health and are not concerned with the full dimensions of human ecology. Probably no *a priori* decision would be wise. The determination of the numbers of centers might best be left to be worked out by a centers of excellence review committee, the functions of which will presently be described.

15. The principal instrument for assisting the development of centers of excellence would be a development grant. The grant should be specific in its objective, but flexible in its application. It should provide for training, research, and general program support. To conceive center grants as primarily for research purposes would, in my view, be a mistake. If an objective of the grant is to assist universities and research institutes to build interdisciplinary centers of excellence in research and teaching, the grant mechanism should foster the development of institutional strength. The individual investigator should not be the primary consideration in a centers of excellence program. An indirect objective is, of course, excellence in the work of individual researchers and research groups. But development of a field of study is the direct purpose of the centers concept, and to encourage excellence toward this objective requires an emphasis on the relationship of the investigator to the field.

16. There is no implication in this emphasis that scientists are going to be told what to study. No one would be commanded to study human ecology or to study it in any particular way. For those who do wish to study it and to benefit from interaction with disciplines other than their own, a facility would be provided that is now uncommon. There are fields and subjects of inquiry too large and too complex to be successfully investigated by a single individual or small group. Human ecology in its larger aspects is one of these fields. Comparison with physical science achievements may not be apt, but it can hardly be denied that large-scale, formal, and purposive organization has been necessary to advance our knowledge and capability in nuclear and high-energy physics. It has not been established that the creativity of individual physical scientists has been suppressed by the availability of institutions for large-scale investigation of physical phenomena.

Elements of a Program for Centers of Excellence

17. The "center" concept could provide the catalyst that is often necessary to move the universities toward interdisciplinary programs. A "critical mass" of faculty and student interest is necessary to initiate and mantain any new academic program. But the time-consuming difficulties of launching interdisciplinary efforts are great enough to discourage action by productive and heavily committed scholars. Many of the more successful interdisciplinary programs in American universities owe their existence to the incentives and opportunities provided by

Federal or foundation funding. Programs in area studies, in less common languages, in biometeorology and oceanography are examples of the catalytic effect of university response to encouragement and funding from external sources.

18. Do the universities respond to these programs only because money is available? It is doubtful if a mercenary motive could be dominant because a university cannot ordinarily obtain funds unless it can demonstrate its competence to initiate and sustain the new program. The grant of funds enables the interested faculty members to obtain administrative support for a program which interest alone could not launch. A faculty member is to some extent the prisoner of his own discipline. Unless he is able to obtain reliable and continuing personal research support, he cannot afford to be extensively involved in research and teaching outside the mainstream of his discipline. A formalized structure for interdisciplinary work, with reasonable expectation of continuing funding, offers the scholar an opportunity to cross disciplinary lines. In all events the authenticity of university commitment would be assayed in the process of reviewing program proposals by the funding agency. A conscientious and well-informed review should obviate the danger of university programs hastily trumped-up to take advantage of available funds.

19. A program to assist the development of centers of excellence should begin with the establishment of a review committee. Before program proposals were invited, the committee should decide upon a statement of program objectives, the ground rules for the funding of applications, and some indication of criteria for selection. These decisions should provide the substance of a program announcement. They should be sufficiently explicit to elicit the desired response, but not so inflexible as to preclude the exercise of intelligent judgment by a national review committee. They should allow the possibility of unforeseen but promising innovation.

20. During its relatively short existence the Environmental Health Science Review Committee in the U.S. Public Health Service provided the type of body that might have fulfilled these functions of program definition and review. Unfortunately, in my judgment, the Committee neither obtained nor developed the basic statements which should have guided its work. It was therefore unable to provide adequate guidance to the universities in the development of their own programs. Opinions differ as to whether such a committee should function as a study section and should take a positive role of leadership and stimulation in developing a field of study, or whether it should confine its action to a "judicial" review of whatever business comes its way. For as important and difficult a field of inquiry as human ecology, I believe the positive role should be adopted.

21. Whether the review committee should be assisted by a larger advisory body seems to me less certain. A single advisory body would be unwieldly if it were large enough to be truly representative of all interests concerned. It could

not be consulted readily and its range of specialization would make communication difficult. Perhaps a better way of providing specialized advice for the review committee would be to constitute ad hoc panels for specific purposes. In place of an advisory committee a roster might be prepared of scholars in the United States and Canada who would agree to serve on such advisory panels. This method would have the advantage of involving a larger number of qualified persons in a center of excellence program without incurring the inconveniences of a large standing committee.

22. The review committee would then have the following initial tasks to perform:

(1) Formulate a statement of the objectives of the program and of the means proposed for its attainment.

(2) Establish procedures for making grants.

(3) Determine the criteria upon which assistance will be provided.

(4) Prepare a roster of scholars indicating their special fields of competence and their availability for advice to the review committee.

Once the first three of these tasks were completed and the results published, the program could enter the second phase in which proposals could be reviewed and grants made.

23. The importance of its tasks indicates the importance of the selection of the committee members; there should obviously be an interdisciplinary mix. The size of the committee ought to be large enough to obtain a variety of experience, but not so large as to impede communication and working relationships that would be particularly important in the earlier stages of its work. A committee of nine to 15 would seem adequate for purposes of division of labor on project reviews and site visits. Its numbers would doubtless be augmented in the technical phases of its work by Federal agency staff. Staggered terms not exceeding 3 years would be desirable to assure the continuity and vitality of the committee. It hardly needs stressing that its members should represent demonstrated competence in the study of man-environment relationships and should have at least a general understanding of the objectives of the program and a sympathy with those objectives.

24. What would be the distinguishing features of centers of excellence? No attempt will be made here to deal with the National Institute of Ecology idea except to note its relevance to the proposed program. If a series of institutes were established in relation to large natural ecosystems in the United States and Canada, some of these might be focused on human behavior in relation to the environment. Useful relationships might be developed with the urban observatories program sponsored by the National League of Cities and the Department of Housing and Urban Affairs, and in which the Office of Education in the Department of Health, Education, and Welfare is involved. University centers

would not necessarily conform to a particular pattern. As previously indicated there would be advantages in variety in interdisciplinary combinations. To optimize the benefits of this variety, provision should be made for ease of transfer by students from one university or institute to another. A center grant program could, through its "ground rules," forestall any parochial tendency in universities to discourage the free movement of students, but safeguards against capricious transfer would also be desirable.

25. One feature of the academic centers that would seem to me to be essential is that their output in people or publications have practical relevance. Their principal justification is an impending crisis in human ecology. Although they should contribute to theory and draw upon it, their mission is the marshalling of verified knowledge for action. It is for this reason that I describe the larger dimensions of the effort to which they would contribute as a "Manhattan Project" for human ecology. Their structuring in the university should facilitate this practical relatedness, and for this reason they should bring the sciences (including the social and behavioral sciences) and the professional field of public administration, urban government, law, and medicine into closer relationship. These centers should build upon what we have been learning about effective ways to obtain coordinated interdisciplinary research. Hopefully, some centers would also emphasize the education of public officials for environmental management. Other centers might emphasize international problems and the training of students, technicians, and administrators from abroad. The range of possibilities is great and it should be a responsibility of the review committee to see that the full range was developed.

26. Communication among the centers should be facilitated by periodic reports prepared and distributed by the sponsoring agency, and by periodic meetings of the heads and principal staff members of the centers. This communication effort should be extended to a wide range of related civic, professional, scientfic, and governmental agencies (the American Medical Association, National Sanitation Foundation, American Association for the Advancement of Science, for example). Widespread interaction among the centers and the concerned sectors of society is one way to maintain relevance.

27. The assumption made at the outset of this paper has been that a centers of excellence program and a review committee would be established within the Department of Health, Education, and Welfare. This is, however, a tentative and operational assumption. Its validity depends upon two considerations. First, assuming the initiation of a program, would the Department of Health, Education, and Welfare or the U.S. Public Health Service be the best place to locate it, and second, would these agencies be favorably disposed to receive it? For the past few years the answer to the research question has appeared to be "no." Even in periods of financial stringency, however, agencies do have some margin of discretion in their use of funds. For example, an administrative reservation

of funds could provide a means of initiating a centers of excellence program. To initiate a significant centers program could be expected to cost, on an average, $750,000 per center on a 3-year basis.

28. The Ecological Survey and Research bill introduced into the Senate by Gaylord Nelson would have established a facility for research support in the Department of the Interior. How far this program might go to assist human aspects of ecology cannot presently be determined. Proposals to establish a council for environmental quality or ecological advice in the Executive Office of the President either explicitly or by implication, indicate that research facilities will be enlarged to provide the information necessary to a national policy for the environment. And there is growing talk of creating a national department for the environment that might provide a more logical home for a human ecology program than does the Department of Health, Education, and Welfare. These possibilities are, of course, conjectural. A vigorous and imaginative support for the study of human ecology by HEW and the Public Health Service would in any case meet a major national need and would receive widespread support among informed sectors of the public.

Creation of Public and Professional Awareness in the Field of Human Ecology

HOWARD ENNES, M.P.H.
The Equitable Life Assurance Society of the United States

Synopsis

IT IS CRUCIAL that we get to the business of setting goals in broad areas of personal and community health and human ecology and also in terms of specific intermediate actions. We are confronted constantly with the dilemma of determining priorities, questions of values, and scales of effort.

There is no substitute for an aggressive drive to intensify co-operative *action*-planning for a responsible approach to human ecology. Planning, as well as control of money through such devices as Federal block grants, must provide for true citizen-consumer involvement and participation. There is urgent need for action which can inform and educate and dynamically involve the total citizenry in the life and death issues of human ecology.

The time has come to seriously consider the feasibility of facilitating a nation-wide effort to create a concept of "ecological citizenship." The individual needs help in recognizing and fulfilling his own responsibilities relating to the environment. A joint venture, providing such help, could be funded and participated in by governments and the various elements of the private sector, but with a significant degree of independence and autonomy from special interests, including governments. The joint venture should be research-based as well as action-oriented. Its policy direction should be shared by a broadly-based council on citizen participation for community health. This proposal for a joint venture is offered in terms of placing today's considerations of human ecology in a setting that is truly relevant to the future of this Nation.

Mr. Chairman and distinguished colleagues:

My assignment, as I understand it from the Symposium Statement, is to set forth issues with respect "to the need for action for positive changes in attitudes and actions that will benefit man in his environment . . . placing man at the center of efforts to protect and improve the environment."

This is a formidable assignment. Frankly, I am appalled by my audacity in accepting your invitation to open discussion of these critical issues before such a distinguished and informed gathering. Perhaps, however, I am here in part because I'm not (directly at least) of the personal health establishment nor am I an environmentalist.

Indeed, I think of myself first as an individual, a citizen-consumer. For that matter, I consider my occupational role to be largely consumer-oriented. Life insurance, after all, is concerned first with people and the quality of their living as well as their longevity and the stability of the economy. And in our health insurance efforts we have a basic responsibility to help assure the productive application of premiums for health care—no small task. This very day, for example, private insurance companies will pay out more than $16 million in health and medical expenses—six thousand million dollars this year—on behalf of more than 100 million citizen-consumers.

Hence, personally and officially I am concerned about the issues of the Symposium and the need for "creation of public and professional awareness in the field of human ecology."

At this stage of the Symposium after Sunday evening's inspiring exploration and yesterday's stimulating probings, it would be my guess you might be receptive to some specific thoughts for action such as those just proposed by Doctors Sargent and Caldwell and to be suggested by Mr. Linton. I would suspect you might even agree with Lewis Carroll's Walrus: (*1*)

"The time has come, (he said) . . .
  To talk of many things:
Of shoes—and ships—and sealing wax—
  Of cabbages—and kings—
And why the sea is boiling hot—
  And whether pigs have wings."

Some of the things, then, that I'd like to talk with you about this morning include goals and priorities, planning and participation, and ecological citizenship—all in the context of creating awareness of human ecology.

At the outset, however, and with your indulgence, let me take a few moments to sketch the setting for my suggestions. I'll begin by recalling a remark of Thomas Carlyle about a century ago. He said to an American friend: (*2*)

> "You won't have any trouble in your country as long as you have few people and much land, but when you have many people and little land, your trials will begin."

Many here would agree. Certainly we do have a "people problem" in the United States today. People and their works and at their play and in their living create environments that threaten to destroy us all.

Ewald (*3*) gets to the heart of the issue when he says:

> "Calling this a second revolution or an extension of present industrial growth does not diminish the impact of the awareness that we are fast building an environment that is more than the body, the mind, or the spirit can bear."

What to do? Get rid of the People? Admittedly people are harder to deal with than things, but people-removal hardly commends itself to a democracy—even though we have toyed with the technique in our urban renewal efforts, with consequences that are nothing short of disastrous.

Of course there remains the all-to-likely possibility that the environment can be removed. Our young people, at least, are acutely aware that there is the bomb and that there are fools and ill people and paranoid political forces still at large. Nevertheless, mass destruction not only is undesirable but the outcome would be even more of an environmental and ecological problem than we have today—as difficult as that may be to conceive!

What to do? An accommodation? We've been trying that—but it appears to me that most of the time we have been asking people to accommodate . . . to adjust . . . to move over. Somehow, we've got our values mixed up, and our responsibilities misdirected. We and our technology seem to be doing our best to make the world increasingly dehumanized. As Robert Theobald said just a couple of weeks ago: (*4*)

> "If we continue in the direction we are going today, we will make this world uninhabitable—not because we want to, but because we don't care."

Theobald is cautiously optimistic . . . at least he feels that this grim future is "not inevitable—just very probable."

And hear a physicist turned botanist—Dr. David M. Gates—who feels that man cannot survive on earth five more generations unless he changes his attitude toward the natural world that supports him. Dr. Gates notes that: (5)

> "The relationship of man to his environment is an elusive subject. We can train telescopes on the galaxy or deliver rockets to the moon or Mars but we do not understand the landscape about us. Unless we learn more about the dynamics of the green earth, we may not be here to look at the galaxy or visit the moon.

We may go down in history as an elegant technological society which underwent biological disintegration through lack of ecological understanding."

And now let me ask you to listen to a poet—the most practical of the disciplines—through the world of Archibald MacLeish who says so much better than I what I want to convey to you. MacLeish was speaking of a time not long after Hiroshima; a time when: (*6*)

"Our belief in ourselves declined at the very moment when the Russian belief in the mechanics of the universe confirmed itself. The freedom of science to follow the laws of absolute possibility to whatever conclusions they might lead had been established, or so we thought, as the unchallengable fixed assumption of our age, and the freedom of technology to invent whatever world it happened to invent was taken as the underlying law of modern life. . . . No one," MacLeish said, "thought any longer of asking whether (the) new idea matched a human purpose.

"What was happening in those years . . . was that we were ceasing to think of ourselves as men, as self-governing men, as proudly self-governing makers of a new Nation, and were becoming instead a society of consumers: recipients—grateful recipients—of the blessings of a technological civilization.

"But," the poet points out . . . (we) "missed the essential fact that we were becoming a population of consumers, an affluent society, not because we preferred to think of ourselves in this somewhat less than noble role but because we were no longer able to think of ourselves in that other role—the role our grandfathers had conceived for us two hundred years ago. We were not, and we knew we were not, Whitman's Pioneers O Pioneers.

"It is here, rather than in the floundering failures and futile disappointments of Vietnam, that this famous frustration of ours is rooted." Mr. MacLeish feels: "Vietnam alone . . . could never have produced, in a confident and self-reliant people such as the Americans once were, a mood like the American mood of these past months. Not even the riots . . . could have afflicted us as we are now afflicted if we had still believed that our principal business was the making of a Nation, the government of ourselves.

"Indeed the riots are, if anything, the consequence, not the cause, of our self-doubt—or, more precisely, the consequences of the actual causes of that doubt. It is not without significance that the targets of the mobs in the burning streets are supermarkets and television outlets rather than the courthouses and city halls which would have drawn the mobs of earlier times. . . . Mobs strike for the Bastille in any rising and the Bastille in the United States today is whatever stands for the American Way of Life: the goods and services, the material wealth, which the majority claim as the mark of their Americanism and which the minority are denied.

"It is because we are unwilling to recognize this fact and unable to face the crisis as a crisis in the long struggle for the creation of a true Republic—because, indeed, we are no longer primarily concerned with the creation of a true Republic—that the majority respond to these riots with nothing but a demand for more police and more repression. . . .

"Which means, however we put it," Mr. MacLeish says, "that we no longer believe in man. And it is that fact which raises, in its turn, the most disturbing of all the swarming questions which surround us: how did we come to this defeated helplessness? How were we persuaded of our impotence as men? What convinced us that the fundamental law of a scientific age must be the scientific law of possibility and that our human part must be a passive part, a subservient part, the part of the recipient, the beneficiary . . . the victim? Have the scientists taught us this?" the poet asks.

"A few months ago," he says, "one of the greatest of living scientists told an international gathering composed of other scientists. 'We must not ask where science and technology are taking us, but rather, how we can manage science and technology so that they can help us get where we want to go.'

"It is not reported," Mr. MacLeish remarks, "that Dr. Rene Dubos was shouted down by his audience, and yet what he was asserting was precisely what we as a people seemed to have dismissed as unthinkable . . ."

Perhaps this has been the long way around to get to the issues before us. But for me, at least, one point is pertinent: Professionals and scientists and public service administrators must recognize the chasm separating science and technology and public policy from the citizen-consumer. The "professionals" must actively seek to bring forth an effective partnership simply for the sake of survival—not to speak of the quality of survival—particularly in the field of environment and health—the field of human ecology.

To be very practical for a moment, rather than philosophical (although I'm not so sure the differences are as great as the law of possibility suggests), what we really are talking about is involvement and participation. Perhaps this is oversimplification. But to me this is what the issue of creating awareness and action actually comes down to.

Perhaps, also, it is too simplistic and logical to think first of *goals and priorities*. Yet considering the state in which we find ourselves, why not try?

Earlier discussions amply illustrate the need to determine where we are going, and why. It is crucial, it seems to me, that we get at once to the business of probing and proclaiming goals on a broad yet specific basis—in broad areas of personal and community health and human ecology, but also in terms of intermediate actions—for we are a Nation of pragmatists and even though we hope to live in the long run, we act mostly in short-run terms . . . this year's balance sheet, 2-year congressional terms, 4-year presidential cycles!

So as a Nation, as professionals and organization-people, as individual citizen-consumers we are confronted constantly with the dilemma of priorities and the allocation of resources. Shall first we attempt to build and improve the physical environment—the streets, the transportation facilities, the housing, commercial, and cultural structures? Or shall we try to improve the lot of people, especially in the cities—to provide meaningful social roles for all through relevant education, by providing training and job opportunities, and access to community health and welfare services? Or should we be looking to ways and means of enhancing the economic development of the community and its people, and rest our case on the regenerative capacity of our productive system?

Obviously, there is no unilateral approach; not one, but some of all, in some dynamic balance. And the dilemma of priority remains—and questions of scale of effort; in short, questions of values. One might suggest that at the present time the dilemma might be resolved with renewed emphasis on the human equation, on human ecology.

To be sure, we must continue our economic development and build and rebuild our physical plant, for these efforts can be generative. But I think all of us, not only we in business, see the central importance of a job—the need for a piece of the action; for a meaningful role in the mainstream, socially and economically—for those who have been deprived of opportunity.

It seems to me that the recent "Congressional White Paper on A National Policy for the Environment" (7) begins, at least, to get at this issue of goals and priorities. And it speaks, as do we in business, of involvement in the action. Point four of five policy proposals reads:

> "Education shall develop a basis of individual citizen understanding and appreciation of environmental relationships and participation in decisionmaking on these issues."

Further it suggests:

> "Public awareness of environmental quality relationship to human welfare must be increased. Education at all levels should include an appreciation of mankind's harmony with the environment. A literacy as to environmental matters must be built up in the public mind. The ultimate responsibility for improved maintenance and control of the environment rests with the individual citizen."

This line of thinking points directly to issues of ***planning and participation*** as part of a dynamic equation which also embraces affirmative educational action . . . of which more in a moment.

First, to this topic of planning. Frankly, I can see no substitute today for an aggressive drive for effective comprehensive community health planning—

action-planning as I like to think of it. Matters are so out-of-hand with our present nonsystem of personal and community health care—with little attention being given to environmental considerations. With the absence of meaningful consumer participation, and with skyrocketing costs—that I personally can see no sense in not trying hard to develop ways and means of assessing needs, identifying resources, setting priorities—all in the context of national, community, and individual and family goals.

We have, in fact, at hand useful concepts currently labeled "comprehensive health planning" and the "partnership for health." They have broad bipartisan support in the Congress, and however labelled, the concepts are sound. We have done less well in implementation, but in all honesty, this effort to turn around a nonsystem and to develop a social and economic rationalization has proceeded remarkably in less than 2 years!

We need now to intensify our energies toward development of more viable processes of cooperative planning for equality in health care and for a responsible approach to human ecology—and the direction of equality must be upward, not toward a low common denominator.

Even as it has emerged thus far, the comprehensive health planning concept offers significant opportunity for creating public and professional awareness in the area of human ecology. Principally this is because community health planning offers opportunity for increased citizen involvement in determining needs. identifying resources, and setting priorities.

Regrettably, the degree of authentic citizen-consumer involvement is as yet not great, nor are environmental considerations adequately encompassed. For these and other reasons, relocation of the Federal responsibility from a somewhat narrow line operation, heavily influenced by grantsmanship, to a broader base in the Department of Health, Education, and Welfare is needed, I think.

Even so, experience by private insurance through its nationwide Health Insurance Council Community Health Action-Planning effort—HICHAP—suggests new dimensions of a practical partnership of governments, professions, the private sector, and citizen-consumers.

Let us continue to be "practical" however, and note that many of these efforts have been in the nature of supportive and/or interpretive efforts for professionally determined goals. Less often do these provide real opportunity for inputs reflective of community/consumer needs and initiatives.

In point of fact, "involvement" and "participation" go to the issue of *control*—control of values, of direction, and of implementation. A more candid approach to this issue of control in the field of health and environment is in order. Too often have we heard the plaints: "But the layman can't know what's good for him!" and "We can never find the real leaders of the community!"

May I suggest that it is no easier to discover "who speaks for the citizen-consumer?" than to find authentic and responsible spokesman in "establishment" fields. But the attempt must be made, in full faith, and it must be made successfully and soon, at the peril of adding to the disintegration of our society.

This thrust for involvement and participation and control is becoming what quite correctly, I think, the sociologist Herbert Gans calls the "equality revolution." The social protests of the day—to which health and environmental interests will remain immune not much longer—are taking many forms. As Gans says, (*8*)

> "Some will ask for *equality*, pure and simple; others will press for more *democracy*, for greater participation in and responsiveness by their places of work and their governments; yet others will ask for more autonomy, for the freedom to be what they want to be and to choose how they will live. All of these demands add up to a desire for greater control over one's life, requiring the reduction of the many inequities—economic, political, and social—that now prevent people from determining how they will spend their short time on this earth."

If control is crucial—and I am sure you will agree that it is—then one must necessarily confront the issue of money. And I think it will be this issue—specifically the issue of block grants—that will bring the true test of our national compassion and integrity, and of our local-State-Federal partnership concept.

There is good reason to be wary of moves such as block grants, *if* they are to be but a subterfuge for returning control to a power structure which was proved largely irrelevant to today's problems. Such would be no improvement on federally controlled grants which have admitted deficiencies even though in many respects they have been effective in shaping vital nationwide efforts.

There is reason for concern if the unstated objective of renewed efforts to allow "self-determination" in disposition of Federal monies via the States means merely more of the same in special interest control . . . for that will almost surely mean more despair and defeat among the poor of our inner cities.

But the block grant concept could signal a rebirth of hope that our states and our cities can cope with the human condition. It could mean that we might try to tackle the issues of state and local governmental reform. Discussing "New Institutions to Serve the Individual" before the American Institute of Planners, Alan Altshuler of MIT puts it this way: (9)

> Increasingly there are Federal programs that provide bonuses to grantees who link the program's implementation to statewide or metropolitan planning processes. It would be no more than an extension of this concept . . . to provide large bonuses in the coin of increased discretion to local areas whose governmental systems met specified criteria. Any precise scheme would be

highly controversial, but the arguments against block grants without State and local governmental reform are quite overwhelming.

> "The core of my argument" (Altshuler says) "is that the Federal government should conceptualize its interest in terms of a relatively few key variables. These might include the following: racial nondiscrimination; some standards of racial and class integration in education and housing; minimum budget proportions spent on such broad 'program package' categories as education, transportation, and environmental purity; and so on. For the rest, it should concern itself with ensuring that local government meet high standards of representativeness and competence."

Combining the block grant idea with cooperative planning just might help to renew the genius of democracy in this segment of our living. We must come back, however, to the individual and to control. This, Theobald (*10*) tells us, is

> "A vital key to our new society. Without it we have no chance of survival for the next 10 years, let alone the next 50. Each man must be given power over his own life. To place this in context we must cease to plan for people. We must begin to plan with people. Planners are reluctant to make this shift, for people foul up systems, they get in the way. They make things untidy, they have whims, ideas, loves, hates, emotions; master plans don't have any room for the freedom of people.
>
> "The planner must destroy the belief that he has made 50 years of progress. If he is to do any good in the city and in the ghetto in the next 6 months and the next 50 years, the planner will do it as consultant to people who live in the communities he is trying to change. He must cease to tell them what they ought to value and instead, in consort with them, design environments which will provide them with the capacity to develop their humanness."

Theobald's point is applicable to human ecology. There really is no short cut to bringing about "changes in attitudes that will benefit man in his environment . . ."

Frankly, I think we have to take a chance with democracy (that's a small "d" democracy!)—perhaps our one last (and yet our best) chance. And naturally I mean involving democracy . . . the exploration of needs and resources and the setting of goals and priorities and the determination of timing in concert with all who are concerned and affected.

This is a process approach, and in the view of some, perhaps a clumsy and slow approach, for it presupposes the creation of understanding among and participation of a large proportion of those concerned.

Time-consuming? Perhaps. But look around us—if you can see through the smog; sniff the atmosphere—if you dare; try to get from here to there for a better view of "America the Beautiful"—if the concrete of our highways has left anything to look at and if you can see over the mounds of city garbage. We really haven't done so well, handing down "solutions" and "planning for."

You will recall that the Congressional White Paper (*7*) called for "a literacy as to environmental matters" in the context of "individual citizen understanding . . . and participation in decision-making . . ." And 16 months ago the Secretary's Task Force on Environmental Health (the Linton Report) called for (*11*)

> ". . . an integrated effort for health education and general education to create a public understanding of its environment and an increased awareness of the individual and social responsibility in reference to it."

Coupling these aims with what I've been trying to say this morning about goals and priorities, and about planning and participation, it certainly should be clear enough that there is urgent need for action which can inform and educate and dynamically involve the total citizenry in the life and death issues of human ecology.

We can, I think, get on with such a task, although in today's complex society I am not sure we can go at it in a traditional laissez-faire manner, nor with an "elite" attitude. Eric Sevareid (*12*) describes a trend and a problem—both pertinent to our issue:

> "We are not becoming less democratic but more democratic. It could be argued that we are moving away from representative government in the direction, at least, of direct democracy, by no means an unmixed blessing. For the immediate future, the problem is not only the indifference or 'apathy' of the much-abused middle class or any other group. It is also the problem of too many untrained cooks in the kitchen."

We could apply the "untrained cooks" notion to many of our professional colleagues—as Professor Dubos has so elegantly documented—insofar as their grasp and acceptance of the concept of human ecology is concerned. And once we get beyond technological and specific professional competencies, we certainly find a lot of "untrained cooks" in business and industry, in the halls of our legislatures—and, yes, among academicia insofar as there is evidence of their ecological understanding.

With all of these "untrained cooks" in the kitchen—although there seem to be quite a few "supervising chefs" among them—why should we presume to add some more—consumers, citizens, community people and leaders? With all I've said, there's no need for me to repeat "why." But we must face the reality that little or no effort has been made to train the cooks or even the chefs. We've spent millions on professional training of many types (although little on ecological aspects) but virtually nothing to help citizen-consumers prepare themselves.

It seems to me that the time has come to seriously consider the feasibility of facilitating a nation-wide effort to create a concept of "ecological citizenship."

I see this in very broad terms, obviously including professional preparation and continuing education, and related research and development. These elements I'll not elaborate upon, for the first priority should be the individual as a member of his community and of his family—citizens who are earners, managers, parents, professionals, legislators—all of us!

We begin—as perhaps we must also end—with the individual. Our purpose should be to facilitate his understanding of his world, his resources, his opportunities—and his responsibilities.

Perhaps it is well to start with "responsibility," the obverse of the coin of "rights." It is well to acknowledge, also, that the "right" to health care now is a political fact of life. We should observe that the demand for "rights" and the press for "consumer participation" stem from unhappy experience of millions of individuals in trying to deal with their real and pressing needs.

So I see urgency to create a concept of ecological citizenship (of community health citizenship)—an effort to be actively joined in by governmental and private and voluntary sectors, by professional and lay groups, by individual citizen-consumers, and all its levels of activity: local, regional, State, national.

The tenor would be facilitative, sharing, educational—and oriented toward action. The focus would be on the individual as a whole man in a cohesive community, and on individual needs and responsibilities . . .

First, responsibility to know himself and to know his environment, thus to shape his life style so as to maximize his personal options for living fully.

Second, responsibility to utilize health services and environmental supports, both personal and community, with optimal efficiency and economy.

Third, responsibility to participate constructively in community health and environmental planning in priority-setting, and in decisionmaking.

If the citizen-consumer is to learn to function constructively and healthfully along these lines, he will need help. You can't talk individual responsibility without resources and authority. Consider, for example, the responsibility of the individual to know himself, particularly the individual in the city where our problems are most acute. Ralph Ellison puts it this way: (*13*)

> "I think that one of the things that we can do about the city is to look at it, to try to see it not merely as an instrumentality for making money, but a place for allowing the individual to achieve his highest promise. And with that in mind, you would try to construct a city or reconstruct a city in ways which would encourage a more gracious sense of human possibility. You would teach, if at all possible, the immigrants, whether they are black or white

or brown, that there is certain knowledge which one must have in order to live in the city without adding too much discomfort to his neighbors."

Perhaps, however, we could be a bit more optimistic? It's not merely avoiding problems that must be our concern, but how to facilitate the individual's capacity to cope with and to shape the human condition. Given half a chance, he does rather well. As Webster College President Jacqueline Grennan (*14*) says a great need in education:

> "is to enable an individual to find his own voice, to speak with it, to stand by it . . . Learning is not essentially expository but essentially exploratory."

The issue before us, then, is how to facilitate—how to provide the conditions and the opportunities—for the creation of a sense of ecological understanding and exploration, a concept of community health citizenship.

To do so in our increasingly complex society, one probably must think in terms of some structured instrumentality . . . just talking will get little done; these days there has to be staff and facilities and money!

Assuming, then, that some instrumentality would be needed, what criteria might we use in building it? I'd suggest, for example, that its concept and organization had best be compatible with our pluralistic society and have a significant degree of independence and autonomy from special interests, including governments.

Certainly it should be comprehensive in scope—meaning not only whatever one means by "comprehensive health" but encompassing personal health in all its ramifications (age groupings, problem categories, services, etc.) as well as ecological and environmental aspects.

It should be research-based as well as action-oriented. The latter is obvious, and as for research elements, I'll not quarrel with those who argue for more facts and better scientific understanding. But one can also agree with Professor Dubos that we can't wait for the final data to come in, for they never will. We've got to go with what we have—which is a great deal more than we are using, both as regards personal health and environmental knowledge and practices, and the techniques and concepts and insights concerning communication.

And, finally, there must be the reality of involvement of community-citizens and of all segments of our society. Involvement and participation represent, in fact, the principal resources which must be mobilized if ecological understanding and action are to result.

There are at hand truly immense resources, substantially underutilized, functioning in a variety of guises and at differing levels of effectiveness and oft-times, it appears, moving somewhat at cross-purposes—although one wonders how much of the apparent conflict is deeply-rooted and how much is the result of unfamiliarity and poor communication?

The resources I have in mind are obviously, governmental (all branches and at all levels); but more important for our purposes, the aggregate of voluntary health agencies and the environmental organizations, the professions, business and industry, labor, the conservationists in all their manifold forms, the Urban Coalition elements and other community institutions—schools especially, and the churches and fraternal, service, and neighborhood groupings, etc.

I see these resource-elements being brought together in some sort of working cooperative or partnership, with a national and perhaps regional "laboratories" for the development of models and techniques for testing and replication throughout the Nation.

This might be a "joint venture," so to speak, funded and participated in by governments and by the various elements of the private sector. I do not see it as the parochial property of any operating unit of government, whether environmental or personal health in orientation, for its effectiveness would be limited.

Its policy direction and management would be shared by a broadly-based council on citizen participation for community health. Perhaps this group might also serve a consultative role to the proposed advisory group on human ecology and to such other units as may emerge as we proceed toward rationalizing Federal health policy development and effectively facilitating comprehensive community health planning.

There is no need, it seems to me, to sketch out here the multidimensional programs and activities which such a joint venture might embark upon through application of modern communication and learning theory, working with the educational systems and through the media and with the communities and citizen-consumers and their institutions.

The point is simply to get on with the task, for it is overdue. And I would guess that in terms of the level of expenditures we are accustomed to these days, the costs in terms of human benefits are modest indeed.

But such a joint venture must be backed up with funds, not only for its immediate operations and outreach efforts, but through established programs. Funds should be available for this sort of "health education" and "citizen-consumer participation" effort in all of the ongoing federally-aided programs—for example, comprehensive health services, manpower, mental health, regional medical, child health, Medicare and Medicaid, rehabilitation, education, Model Cities, and, of course, consumer protection and environmental services.

Whether or not these proposals are worthy of serious consideration, I leave to this distinguished audience. It seems that we should, however, place today's considerations of human ecology in a setting th[illegible] truly relevant to the future of this Nation.

I am thinking, particularly, of the human condition as it exists in our urban communities. And I am thinking of the goal set by the National Advisory

Commission on Civil Disorders . . . "a single society and a single American identity."

You will recall that the Commission outlines three objectives for national action: (*15*)

1. "Opening up opportunities to those who are restricted by racial segregation and discrimination and eliminating all barriers to their choice of jobs, education, and housing.

2. "Removing the frustrations of powerlessness among the disadvantaged by providing the means for them to deal with the problems that affect their own lives and by increasing the capacity of our public and private institutions to respond to these problems.

3. "Increasing communication across racial lines to destroy stereotypes, to halt polarization, end distrust and hostility, and create common ground for efforts toward public order and social justice."

It seems to me that these objectives should be especially meaningful for those of us who voluntarily have chosen the professions or the activities which impinge on human ecology and health.

As an individual I can see no alternative to these tests of our national compassion and integrity. They give us a sound basis, as the poet (*6*) suggests, on which we can renew our belief that our principal business is "the making of a Nation, the government of ourselves" in the sense of the interdependence and wholeness and humanness of man.

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Strategy for Improvement of the Status of Man in His Environment

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Synopsis

MAN, HAVING DEGRADED the environment, is now faced with the urgent necessity to define a hospitable environment and to devise a strategy for achieving it. National policy must include how we are going to handle wastes, how we are going to pay for handling wastes, and how responsibilities are going to be assigned in handling wastes. This means appropriate sharing of responsibility by the private sector and Government at Federal, State, and local levels. Agencies must act on the basis of the knowledge in hand.

The Consumer Protection and Environmental Health Service must be the lead agency in formulating and implementing a new national philosophy. It must have four resources to implement strategy: (1) a science base in order to identify what is in the environment; (2) the ability to establish criteria and standards;

(3) an applied technology program to create devices necessary to achieve the standards, and (4) the ability to obtain compliance. These four capabilities rest almost entirely on the availability of competent manpower.

The most important part of the strategy is the development of action programs. Priority action programs include: programs of population dynamics, programs to establish attainable levels of achievement, Federal grants-in-aid to local and regional governments for area wide environmental protection systems, and specific targets in order to know whether the strategy is taking us to our goals. Ten targets are suggested.

Knowing how the environment injures man and knowing how to improve the environment so it will not injure man will provide the means for defining a hospitable environment.

IT HAS BEEN STATED that man's survival depends upon the existence of a hospitable environment. It is probably more accurate to say that man's survival depends upon his own ability to keep from destroying his environment. Preurban and preindustrial man only sensed that fact; modern man must come to understand it.

He must come to understand it because the evidence shows that he is threatening himself with an inhospitable environment; that he is increasing this threat at an alarming rate.

Modern man has abused his environment more in the past 100 years than his predecessors did in thousands of years. And like his predecessors he is doing so through ignorance. Ignorance despite a century of probing and searching to scientifically delineate the relationship of man to all that surrounds him.

For even with the accumulation of 100 years of knowledge, man is only beginning to understand how his health is jeopardized by environmental degradation. He has yet to learn how environmental pollution relates to social pathology. He is hardly able to define "hospitable environment."

Modern man continues to assume that because for thousands of years nature seemed to have the ability to absorb an increasing number and variety of environmental insults, it would continue to do so. Man still does not clearly understand that, as we wrote in "A Strategy for a Livable Environment," he lives "in a delicate equilibrium with the biosphere—on the precious earth crust, using and reusing the waters, drawing breath from the shallow sea of air."

Because he does not understand this he is now faced with an urgent necessity for defining a hospitable environment, not just one in which man merely survives but one in which he flourishes.

The need for such urgency was underscored by David M. Gates, Director of the Missouri Botanical Garden, who wrote, "Mankind has lit the fuse of the environmental bomb. It is not a question of whether or not it will explode, but only a matter of how fast."

The urgency is such that we must act to stop environmental degradation with greater speed than ever before. We must develop information more rapidly. We must make decisions quickly. We must quit pontificating and fix responsibility for action.

We must have a strategy for improving the status of man in his environment if we are to uplift him materially and spiritually. That strategy must be to understand what we are doing to the environment and be able to stop doing that which has ill effects on man.

It must be a strategy to achieve the highest quality environment man is capable of achieving. It must be a strategy that incorporates concern not only for the traditional physical health of a human being, but for his mental well-being as well, and that accepts that an integral part of both his physical and mental health is concern for the aesthetic quality of the life surrounding him.

Preindustrial America was not cognizant of environmental deterioration in the sense that society is today. Then, the debris and filth of society's wastes were accepted as a concomitant of life. Then, there was barely emerging the germ theory of disease and the understanding that there was a relationship of illness and death to the degradation of the physical environment.

The prevailing national philosophy that emerged in the early 1800's and blossomed out with the advent of the Industrial Revolution in the United States, was for expansion and development.

We were a growing Nation, a building Nation, an expanding Nation. We needed to use our space, our water and our air. These resources were used to feed development and expansion. The demand was for mechanical devices and apparatus that moved man faster from one point to another; that allowed him to live more densely and in ever greater areas; that allowed him to communicate more rapidly; that allowed him to build day and night.

We were preoccupied with using. The concept of conservation was yet to be born. This national philosophy ran nearly unchecked for the balance of the 19th century. By the opening of the 20th century a growing number of individuals began to apply the brakes to the indiscriminate abuse being delivered against the environment by a mankind determined to satisfy wants for an abundance of food, clothing, housing, and products to make life easier and more fun.

Now there is a rapidly accelerating effort by man to protect his environment from his own onslaughts. Now we have called for a review and reevaluation of a national philosophy of growth and expansion that disregards the effect on the environment, and we have begun to modify it.

Now we need a new national philosophy that strikes a balance between the use of the environment to provide material wants and the preservation of the environment to enhance man's physical and mental well being.

Such a philosophy must be underscored by national policy on the environment. This national policy must include how we are going to handle our wastes, how we are going to pay for the handling of our wastes and how the responsibilities are going to be assigned in handling these wastes.

Fixing the responsibilities to be divided between the public and private sector and between the various levels of government is imperative. Assigning an action responsibility is the only way the philosophy, the national policy and the goals which must be set will be achieved.

The private sector, particularly that industry which contributes to environmental pollution by the nature of its activities, has a responsibility to accept the need for environmental quality standards and to work with the appropriate government agency in a positive manner to establish those standards.

No longer can we accept the premise that there is no cost to indiscriminately disposing of wastes in the environment. We know that there is a cost and that such a cost must be fixed and borne by those benefiting from such a use of the environment.

The private sector also has a responsibility to apply its research and technological know-how to achieving ways of preventing environmental damage.

On the public side, it is most appropriate that the planning for environmental improvement programs and their implementation be carried on at the local level. In most instances this ought to be on an area-wide or regional scale. State government must accept responsibility for providing adequate legal basis for local action programs, coordination between local areas within a State, development of compacts with other States, and funding.

The Federal government must assess the total national research effort and undertake extensive research and development to bring into being needed control mechanisms. It must provide technical assistance including substantial funding. Finally, it must be able to provide leadership in establishing high standards of environmental quality.

The Federal government must undertake those things which are too expensive for local and State governments to undertake by themselves, or which the Federal government can do more efficiently on a mass basis than can be done if every local government in the country attempts to do it individually. Even more important, the Federal government must resolve differences which arise between States and local jurisdictions in different States over the quality of the environment that will exist.

Within the Federal government there must be a sharing of responsibility for achieving and maintaining the highest level of environmental quality. It is not possible to assign total responsibility for managing the environment to a single agency. The Department of the Interior, the Department of Housing and Urban Development, to mention just two agencies, have unique roles to play in restoring and maintaining a quality environment.

Yet there must exist at the national level a single focus for policy development and coordination of environmental programs.

The establishment of public policy is a responsibility of the Congress but for it to create meaningful public policy requires assistance from the Executive branch. The President is the point at which executive environmental policy must be made.

Yet the President must look to his Executive agencies for the basis upon which policy is to be determined.

Since the purpose of maintaining a quality environment is to enhance the health of human beings, the focal point of policy evolution and program coordination ought to rest with the Department of Health, Education, and Welfare.

The Department of Health, Education, and Welfare is the primary Federal agency concerned with the broad scope of man's health. The health concern in its broadest aspect must relate to the social environment as well as the physical environment. Thus, the Department of Health, Education, and Welfare should be most capable of relating how man's health is affected by what he does to his environment.

The Department of Health, Education, and Welfare needs to play a dual role. First, it must serve as a coordinator of Federal environmental programs so that all are aimed toward the same goals. This will require supplying other agencies with basic information and other data on the effect on man's health of other program activities.

Second, the Department must act to see that the environment is maintained at the highest quality possible.

We must assume that creation of the Consumer Protection and Environmental Health Service demonstrates that the Department recognizes its dual function and will act to upgrade the environment.

Philosophy, policy, goals, and responsibilities of the private and public sector are all necessary underpinnings for the establishment of an effective strategy for improving the status of man in his environment. But neither their absence nor the lack of agreement on the precise definition of a hospitable environment in no wise prevents the implementation of a meaningful strategy. The strategy must be an action strategy.

If the strategy cannot wait for the development of a national philosophy and national policy; for agreement on specific goals; for acceptance of the public and private responsibility, or for a definition of a hospitable environment, it certainly can't wait for the millenium in scientific knowledge.

The agency responsible for action, for implementing a program and carrying it through, must act on the basis of the knowledge it has in hand. It must be prepared to change and adjust as new knowledge is developed. But it must deal with the real world of the moment.

The strategy for improving the status of man in his environment is to establish the level of quality to be achieved and to apply the resources available to get there. This means technology and compliance.

The Consumer Protection and Environmental Health Service must be the lead agency in formulating and implementing a new national philosophy. It must provide the President and the Congress with the logic and reason for national policy. It must define hospitable environment. To do this it must have the capability for identifying the nature of environmental insult, its effect on man, the degree to which the insult must be controlled and the method of control.

It must, in short, have the four resources or tools to implement the strategy.

First, it must have the resources to identify all that is injected into our environment, in the air, in the water, on the land or in the space we live. It must be able to examine and assess the impact on human health, of whatever man puts into his environment. It must be able to examine these effects individually and synergistically. It must be able to determine not only where they come from but why and what they do to the physical environment and how they affect man.

In order to do this the Consumer Protection and Environmental Health Service must have a science base. Without it, it cannot effectively carry on its other functions. Such a science base is so integral a part of the resources necessary to carry on any program effectively that it must be located organizationally within the Consumer Protection and Environmental Health Service. Buying science assistance from other agencies is at best a supplementary device to an internal capability.

The second resource the agency must have is the ability to establish criteria and standards. It cannot do without its science base.

The third resource which it must have is the ability to conduct an applied technology program which will bring into being the devices and systems necessary to achieve the standards that have been set.

Finally, the agency must be able to obtain compliance with the goals and standards that are established. To obtain this compliance solely through use of the abatement process would signify a failure to develop national goals and a national concensus on environmental quality. Abatement should be a move of last resort, applied to a recalcitrant few. The principal thrust of compliance should be the development of a voluntary commitment at the local level and from the private sector to agree upon quality of environment.

This can be done if there is adequate development of basic data, new technology, and the financial resources to support the economic cost.

These four capabilities rest almost entirely on the availability of competent manpower to carry on the job. An insufficient number of scientists or inadequately trained technicians will prevent the achievement of any goals and render impotent any strategy.

This is true not only for the Federal establishment but for State and local government and the private sector as well.

The Consumer Protection and Environmental Health Service must establish manpower policy and manpower development programs which take into account the kind of capabilities that must exist at all levels of the government and in the private sector in the years ahead.

Today, it is impossible for any agency or individual to provide a reasonable assessment of the numbers of engineers, sanitarians, physicians and public administrators needed to carry on environmental program 5 years from now, let alone identify the new technicians who will be needed in the future.

A key aspect of the strategy must be for action. What programs and facilities the Consumer Protection and Environmental Health Service creates must be measured against what these programs do to change the nature of the environment.

These program activities must be capable of supporting and involving local action.

Yet right now there is no comprehensive planning being done at the local level for improving the quality of the environment. A part of the strategy for improving the status of man in his environment should be for the Consumer Protection and Environmental Health Service to enable local government to do areawide comprehensive environmental health planning.

But comprehensive planning must include providing the means by which a specific agency at the local level can take responsibility for setting and enforcing standards.

Another part of the strategy for improving the status of man in his environment should be to create new towns which have incorporated in their plans achievement of superior environmental quality.

A part of the strategy should be to assign Federal program implementation responsibility to regional offices. This would mean locating in regions the personnel necessary to provide technical assistance and grants. It means putting the tactical capability closer to the problem.

But the most important part of the strategy is the development of action programs.

The most important action program is the need to understand the relationship of population growth, particularly density, to the physical and social environment.

Consumer Protection and Environmental Health Service must undertake to assess the impact of varying levels of population under certain densities to determine what the effect is on environmental quality.

Crowding and congestion is pollution of living space and we must look at human beings as potential environmental insults. We must be as capable of understanding contamination of space by humans as we are of understanding contamination of the atmosphere or water by chemicals. We must be prepared to develop criteria for density. Crowding and congestion have a wider effect on the environment than air pollution or water pollution since an increase in population density multiplies the contamination of air and water as well as producing its own pathology. The Consumer Protection and Environmental Health Service must participate in and contribute to programs of population dynamics.

A second priority action program to carry out the strategy is to establish levels of achievement. It is not enough to agree on an enforceable standard for the moment. True environmental quality will be attained only by setting higher and higher levels of achievement. But merely setting higher ambient air quality goals on paper is a futile exercise. It must be backed up by a vast program of applied technology. The means must be created by which it becomes technically and economically feasible to improve the quality of the environment.

For the public sector the identity of the higher goals and the technical method of achieving the goals still leaves the need of massive funding for the necessary public facilities. Thus a third program necessary to the strategy is one of Federal grant-in-aid on a noncategorical basis to local and regional governments so they can establish area-wide environmental protection systems.

Finally there must be established specific targets in order to know whether the strategy is taking us to our goal.

Target one should be setting a level of improvement in air quality to be sought in 75 major urban areas by a given date.

Target two should be establishing the number of open dumps to be converted to land fill or other effective disposal methods by a given year.

Target three should be defining a clean city and setting a minimum number of demonstrations to test definition by a given year.

Target four should be developing a reporting and control system for illness caused by food contamination and establishing an inspection program aimed at relieving the illness by a given number.

Target five should be determining the condition of the nation's 19,000 water supply systems and providing assistance to bring them up to agreed upon standards.

Target six should be to intensify the efforts to determine the relationship of disease and social pathology to environmental degradation.

Target seven should be the creation of a national environmental surveillance system which would measure gross impact of environmental degradation.

Target eight should be extending health service related to occupational hazards to 100 percent of the work force at the place of work by a given year.

Target nine should be to develop a program to reduce by a specific number the accidents and deaths resulting from the use of unsafe products.

This does not suggest that the foregoing are the only targets which can be set. It suggests only that in the absence of the ability to measure severe environmental deterioration these are the most important and obvious. Setting and pursuing them will force continuing reevaluations of priorities and the strategy itself.

But in the final analysis the success of the strategy can be measured only by being able to measure the quality of the environment.

That is what the Consumer Protection and Environmental Health Service should set out to do immediately. Even as it takes action to improve the obvious it must be able to measure that improvement.

Knowing how the environment injures man and knowing how to improve the environment so it won't injure man will provide the means for defining a hospitable environment.

Summary of discussion following Papers by Dr. Caldwell, Mr. Ennes, and Mr. Linton

The opening discussion was concerned with the relative needs of programs to provide improved individual health services and preventive health. It was agreed that both are needed but that the Symposium on Human Ecology should focus its attention on human ecology and the preventive aspects of environmental problems.

Discussion turned to the need to introduce concepts of human ecology to the public. Introducing the subject to elementary and secondary school pupils by teachers with training in the field was discussed as one possibility. It was pointed out that training of elementary and secondary teachers in ecology and environmental matters is currently inadequate and would need to be greatly improved. It was also noted that professional personnel, such as physicians, lawyers, and others, must be informed about human ecology and their role in advancing it. It was suggested that persons knowledgeable in human ecology seek to participate in meetings of other professional societies for this purpose.

On the question of establishing effective environmental health programs, it was pointed out that a concerted effort over a long period of time will be required because of the slow pace of institutional and political change. It was suggested that a combined effort of governmental and nongovernmental groups will be required to push environmental health programs forward. It was noted that much is being done by various committees and organizations to identify problems and establish priorities for environmental programs but that follow-through action has been lacking. The Department of Health, Education, and Welfare was suggested as the logical agency to provide Federal leadership in this area because of the agency's focus on man. It was noted that questions of basic policy relating to the environment must be resolved at the highest governmental level, probably by the White House.

The need to give attention to the social and psychological aspects of environmental problems was raised. It was suggested that these factors can be incorporated in action programs by giving affected population groups, such as ghetto residents, an opportunity to participate in environmental control programs. There was a general note of optimism in the discussion because of observed increases in interest and understanding of environmental problems by all segments of society.

The value of centers of excellence for human ecology as points for interchange of information and as sources of operational advice on ecologic matters was explored. There was recognition that such functions should be performed by future centers.

Remarks

Honorable Melvin R. Laird
Member, United States Congress

Synopsis

TO DISCUSS the role of government in connection with human ecology, one must first place in perspective the nature of limitations that face us in the form of budgetary problems. These limitations show that our solutions are not going to come exclusively or primarily from the Federal purse. Solving the environmental crisis will require a complex, coordinated effort by National, State, and local governments, by private organizations, universities, and business.

President-elect Nixon has expressed the need for developing "objective standards of environmental quality, and effective, fair means of enforcing them." We must bend our efforts toward defining better than we have so far the basic ingredients of an environment suitable to man. In seeking effective remedies, we need to take a look at a variety of approaches some of which are represented by programs already in existence.

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Consolidating all environmental programs into a single environmental health agency would advance the prospects of greater public and congressional support. In addition, we need a breakthrough, a bold new approach, which can best be achieved by "decentralizing the initiative and the resources" outside the Federal establishment for attacking these problems. For example, tax credits to give industry incentive to curb pollution, or grants to States and localities for correcting environmental problems.

To assure that ecological credits outweigh ecological debits so far as man's total health and welfare are concerned, we need to know more precisely the effects of these insults on human beings and other forms of life. This is a responsibility that the Federal Government must share.

I AM DELIGHTED to be a part of this important conference. And I want to congratulate Dr. Lee, Dr. Stewart, and Mr. Johnson for calling you distinguished gentlemen and ladies together to help them develop a new focus and orientation in dealing with our complicated environmental problems.

There is probably no more complicated subject facing the problem-solvers of the world than this one. And it is complicated still further because human ecology is so closely related to all the other ills that face man in the last third of the 20th century.

If my appearance before such a distinguished audience of experts is to serve any useful purpose, it will not be found in cataloging for you what you already know far better than I. Rather, I might serve a better purpose by trying to place in some perspective the nature of the limitations that face us in our quest for a better life for all. Then I might suggest for your consideration the direction in which I feel we must proceed if true progress is to be made in the immediate years ahead.

The first requirement is to be as candid as I can with you. I would like to do this by listing some hard facts. First, yes, this Nation and indeed large areas of the entire planet are destroying the balance of nature through unwise use of our natural resources, through constant and continuing pollution of our air and water, by overcrowding in our cities and by a host of other abuses that have been spelled out eloquently for you at this conference.

Second, we have definitely reached a time of crucial decision, a time when we must begin to reverse the trend lest we bequeath to our children a heritage of insoluble problems.

Third, there is a war going on in Vietnam that is costing this Nation more than $30 billion a year and even if it ends tomorrow, there is little prospect that our massive defense budget will diminish very much.

Fourth, on last June 30th, the United States closed its books on a fiscal year that ended $25.4 billion in the red. This not unusual imbalance in our fiscal affairs is one direct cause of the economic woes we are enduring in this country today.

Fifth, our new President, like his predecessors, faces a budget situation that is going to force nothing but hard choices in the immediate years ahead. Education demands will be up. Welfare costs will skyrocket. Interest on the national debt will jump. Health needs will multiply. Slum improvement and crime prevention and war costs will continue to compete unmercifully for every Federal dollar that exists. And we politicians who must answer to our consciences and our constituents as well as to our knowledge of what is needed must live with the frustration of being unable to provide all of the dollars and all of the programs necessary to deal with these problems.

I could go on but this should be sufficient to paint the picture I want to paint. I have been asked to discuss the role of government in connection with the subject of your deliberations, human ecology. To do this, I felt it necessary to give you, however briefly and incompletely, a taste of my own frustrations and the frustrations that a Dr. Lee and a Mr. Johnson must face on a daily basis.

No matter how gradiose our plans or how clearly we might perceive what needs to be done in a given area of public policy, there always comes that moment of truth when the cold, hard questions of where the money is coming from has to be faced.

I don't want to belabor this point and I don't want to mislead anyone about my own position. It is *not* my view that we have to bequeath a heritage of insoluble problems to our children. I do *not* believe our budgetary problems are insurmountable or that we can't improve the quality of education, straighten out the terrible problems in our cities, correct the horrible mess that is our welfare system, improve the unemployment problem, or reverse the terrible trend toward an environment that is unsuitable to man.

On the contrary, I do believe that as a Nation, the United States can—indeed it must—make significant forward progress on all these fronts in the immediate years ahead.

The dynamics of the present situation are such that we can either progress or go backward--we can no longer stand still or merely preserve the status quo. All of us want, of course, to move forward and progress.

Why then, did I begin my remarks with the emphasis on budgetary problems? Frankly, because unless we start admitting the fact that our solutions are not going to come exclusively or primarily from the Federal purse, we will be doomed to another generation of grand talk and mean performance.

The question that faces us, ladies and gentlemen is, how best can we insure progress, faced as we are with the impossible demands on our budgetary resources and the incredibly complex nature of our many difficulties?

First, I think, we have to dispel some popular myths. Some seem still to feel that saving the environment or cleaning up the slums or abolishing crime is a matter of money alone, that if only the Federal Government would open the purse strings a bit further, the problems would be solved—and by now all of us should know this is *not* the case.

Others feel that the only answer is for the Federal Government to set up some sort of "environmental manager"—a superagency perhaps—which would tell us all what to do about every aspect of environmental use. This is not only an impractical dream it is an unappealing one. It probably originates in the hope that, after turning all these problems over to some "expert," the rest of us could get on with business as usual. The questions are too complex and far-reaching for this. They involve not one agency, but every agency of government, not one level of society, but all levels. They enter into every step in our material progress, and complicate thousands of daily decisions in commerce, construction, agriculture, and every other activity of a busy modern world. Unless we are ready for the Congress and the President and all the rest of government to go home while we turn ourselves over to a "Controller" out of Huxley's "Brave New World," it is wishful thinking to suppose we can so easily rid ourselves of our concern about the environment.

As with most of the serious problems we face in this country, solving the environmental crisis will require a complex, coordinated effort by National, State, and local governments, by private organizations, universities, and business.

Our greatest challenge, as we approach the decade of the 1970's is to find mechanisms and to institute arrangements that will bring this coordinated effort about.

We must marshal the dynamic forces that made this Nation great and unleash a concerted attack that will lead to cleaner air, less-polluted water, improvement of the conditions in our cities, and a better preservation of our natural resources while countering the undesirable side effects of our expanding technology.

If we can do this, we can create for our people, even with tremendous population increases which are foreseen, conditions that will provide the "good life" which has always been our goal.

President-elect Nixon has made clear his own awareness of this problem and his own commitment to finding ways of advancing the partnership approach between the public and the private sectors in order to make maximum use of the knowledge and the resources this great Nation already has at hand.

I heartily concur in this viewpoint and in the need, as expressed by the President-elect for developing "objective standards of environmental quality, and effective, fair means of enforcing them. We need to match advances in technology with advances in government."

Put these two commitments of President-elect Nixon together and we begin to see a pattern for the future that is essential for progress in this area. On the one hand, we must bend our efforts toward defining better than we have so far the basic ingredients of an environment suitable to man. On the other hand, we must seek in the policy arena to institute programs and arrangements that will maximize the efforts at all levels of our society to fight and to reverse present trends.

At this point in our history, confronted on every side by the ugly and unwholesome results of our past mistakes, few could dispute that one of our most urgent needs is to develop objective standards that show what is actually required to maintain an environment suitable to man's needs. This is a problem of definition that requires the assistance of the best scientific minds in our society. I am glad to learn that the Consumer Protection and Environmental Health Service intends to give priority to this important task.

In fact, the lack of such criteria in several areas of urgent need is probably a major cause of our failure to move effectively against environmental hazards. In the absence of clear options, there can be no sound decisions.

We are something like the airplane pilot who radioed back to his base, "Am lost in fog. Shall I proceed to destination or return to base?" His commanding officer, being a great advocate of personal initiative, radioed back, "Yes." Confused, the pilot called back, "Do you mean yes I should proceed to destination or yes I should return to base?" This time the answer was, "No."

All of us, including Congress and the Chief Executive, who are faced every day with decisions affecting the environment have found ourselves in somewhat the same position as that pilot in our need for clear guidance from the scientific community. We cannot postpone or avoid decision. We cannot be satisfied with ambiguous answers. And we cannot wait for science to understand everything there is to know about human biology and psychology.

We need to consolidate and clarify what knowledge we already have and act on it. Government at all levels, in concert with its citizens, must, as Mr. Nixon has said, find "effective, fair means" of assuring that our knowledge of human ecology is applied.

Perhaps, in some instances, where environmental problems are clearly of a national scope and not amenable to State and local action, effective remedies may require some form of Federal regulation. But as we seek solutions to the multitude of existing and potential environmental problems which diminish the quality of life today and cast an ominous shadow over the future, we need to take a close look at a variety of approaches.

We already have certain programs on the books that represent varying approaches to this problem.

The Air Quality Act of 1967 is one example. It authorizes the development of Federal criteria and distribution of recommended control techniques. While it establishes Federal responsibility to assure clean air, it seeks to promote meaningful action by State and regional agencies to control pollution.

Under this Act the Federal government designates Air Quality Control Regions and approves air quality standards for these regions. In essence, what Congress initiated through this legislation was a program for regional control of air pollution, supported by Federal funds, and based on Federal criteria.

The Federal Water Pollution Control Act addresses itself to this area of environmental control in a somewhat similar fashion. Under that legislation, Congress initiated comprehensive river basin planning for pollution control, with Federal financial assistance. State standards for water quality, to protect their downstream neighbors, are subject to Federal approval. States have primary responsibility for enforcing water standards, but the Federal government under this Act may intervene where necessary to prevent interstate water pollution.

Both the Air Quality Act and the Water Pollution Control Act require that Federal research be directed toward development of the information needed to establish standards to protect the public health and welfare and also require the administering agencies to determine the economic feasibility of various control techniques.

Let me add one word here. If the programs we already have on the books are going to work, they will need support. Putting water pollution control under the Interior Department—separating it if you will from health—was a mistake.

All environmental problems, such as air and water pollution, must be considered as part of a single problem. Proliferating the attack by dispersing it all over the Federal establishment can only dilute the results. Consolidating them into a single environmental health agency will advance the prospects of greater public and Congressional support.

Another program currently on the books which offers a different approach to national problems is the Regional Medical Program, a fine example of cooperation between the medical profession, the universities, private research institutions, and the Federal government. This program provides continuing education to physicians who have been practicing for 5 years or more, in an effort to put into practice the latest advances in diagnosis and treatment in the fields of heart disease, cancer, and stroke.

It seems to me this approach might be considered as a possible model in the environmental area. The problem is not dissimilar from that confronting the medical profession in its need to assure application of new knowledge. But it is even broader, for it is interdisciplinary. Architects, planners, transportation specialists, doctors, State and local health department officials, city managers—the entire domestic side of the governmental effort—as well as decisionmakers in the private sector, need to be instructed and updated on environmental problems and the best methods of avoiding or correcting them.

These programs we have been talking about are in existence. They are operating. And they will meet with varying degree of success as we move down the road. But by themselves, they will not do the job. More is obviously needed. And more we must have.

In this area as in so many others, we need a breakthrough, a bold new approach that doesn't have to begin "from scratch," that doesn't need a 5-year gestation period, that when initiated, it will begin to work.

That kind of a program has to spark existing institutions and give new force to present arrangements. I've said we have to consolidate our efforts within the

Federal establishment itself. But outside of that establishment and, hopefully sparked by it, we need a different emphasis, a decentralized one. We need, in my view, to place primary stress upon a dispersed and decentralized attack outside of Washington. We need this in order to implement a very important principle recently restated by Daniel P. Moynihan, Director of the Harvard-MIT Joint Center for Urban Studies. Speaking to the National Board meeting of the Americans for Democratic Action, Moynihan argued that the Nation cannot be run from agencies in Washington, that "a system has to be developed . . . under which domestic programs go forward regardless of what international crisis is preoccupying Washington at the moment. This in effect means decentralizing the initiative and the resources for such programs."

This is an important principle not only because it will lead to a more rational means of attacking complicated problems across the board but also because it will insulate these efforts more effectively against competing demands for funds at the Federal level. For example, the charge can be made that we seem to be more interested in improving man's potential environment on the moon than we are in correcting it here on earth. A comparison of the dollar commitment at the Federal level between reaching the moon and restoring clean air on earth would certainly bear this out.

We have to do a better job of ordering our priorities in this Federal system of ours.

I firmly believe that this can best be done, in "Pat" Moynihan's words, by "decentralizing the initiative and the resources" for attacking these problems.

What I have in mind, for example, is the institution of a program of tax credits where industry would be given added incentive to curb its own pollution of the air and water. Another program would provide functional grants to States and localities to be used specifically for correcting environmental problems.

These approaches do not necessarily require a smaller involvement or investment by the Federal government than possible alternatives. But they do promise greater effectiveness and can unleash the dynamic forces that have made possible the growth and progress of this Nation.

Experience has shown us—and I can speak with particular knowledge of various programs in the fields of health, education, and welfare—that the approach which attempts to solve every problem from the top down, results in very slow progress indeed.

For some years, we were wedded to the idea of aiding and guiding categorical grant programs, tailormade in Washington to accomplish narrow and specific objectives. Within the Congress, and throughout the Nation, during the last few years, there has been growing disillusionment with the results obtained by this approach. An obvious defect in such plans was that they encouraged the States to emphasize health activities for which the money was available rather than those dictated by their own needs.

Consequently, in 1966, the Congress moved away from the categorical grant system and established block grants to State and regional planning agencies to enable them to attack their health problems according to priorities which they themselves establish. This comprehensive health planning program, which is also known as the Partnership for Health, is an important departure from the traditional approach to Federal spending. This program could serve as a model for establishing effective environmental control programs throughout the Nation, with Federal resources providing the base for State and regional action.

As we seek to find the best means of improving man's environment, let's try to do it in a way that will give everybody a piece of the action. Because everybody, after all, has a stake in the outcome.

I cannot believe, in this representative system of ours, that local and State leaders do not realize their own enormous stake, personally and politically, in finding the better answers, in eliminating the smog and wiping out the slums and upgrading educational offerings.

All of us want to incorporate the best principles of human ecology into our agricultural practices, our city renewal programs, transportation, and all the rest.

The true test of our national leadership in the coming years will rest in how well we were able to exploit the good intentions of all Americans—government officials and private citizens—in moving toward solution of these problems.

There is one vital point upon which I think we can all agree. That is, we need to know more about *what is happening to man* in our contemporary environment, so that government at all levels, businessmen, planners in every field, can make intelligent decisions regarding environmental change.

Commonsense can guide us a part of the way, in some important and urgent areas. We don't need laboratory evidence to convince us that the environment of our city or rural slums is destructive to the human body and spirit. We know that pure food and water are better than contaminated. But there are other aspects of the problem—and components even of those I have mentioned—that are far less clearly understood. In many cases, we must weigh ecological debits against ecological credits in order to come up with a satisfactory balance sheet.

The miracles of chemistry, for example, have helped make possible our abundant food production; plastics and synthetics have brought undoubted benefits. Yet, on the debit side, chemical contamination of the environment presents some frightening threats to human health; the trouble is that, in many instances, we have not even begun to define the nature and magnitude of these various hazards as they collectively affect man.

Obviously, modern man's total health and welfare are dependent upon these products of his scientific and technological ingenuity. We live, and those who come after us will live, in an age of chemistry, of new power sources, of ever-changing and improved technology—in an environment which increasingly bears the mark of man. No one supposes that we can, or would even wish to, restore the world to the perfect ecological balance which it must have had on the seventh day of creation.

Our problem as I said before, is to assure that the ecological credits of the environment we are creating outweigh the ecological debits so far as man's total health and welfare are concerned. And to do this, we need to know—far more precisely than we do now—what the real and total effect of these various environmental insults is on the human organism or on other forms of life important to human ecological balance.

If pesticide residues constitute a threat to human health—and there is no doubt that they do—at what point does the hazard outweigh our obvious need for an abundant food supply? How do pesticide chemicals interact with other chemical pollutants to which man is exposed? Can we assume that judicious pesticide use can enable us to retain the unquestioned benefits while minimizing the undesirable side effects?

These are very difficult and complex questions, and, as you know, they may be asked about many other environmental pollutants—about lead, for example, as a contaminant in the air, water, and food. How much are people actually ingesting—and what is its effect on the body?

I certainly am not suggesting that we cannot act to control these hazards until we know everything there is to know about them and their impact on human health. On the contrary, I am arguing that we move immediately on these problems by instituting new arrangements to unleash the dynamic forces in our society for an across-the-board attack.

But if we are to establish sensible priorities now and in the future, we need at the same time to define our present understanding and to enunciate it as clearly as possible so that we can make intelligent decisions while we continue to seek more knowledge. Certainly this is a responsibility that the Federal government must share, so that all of us, in both the private and public sectors of society will have a clearer understanding of the real consequences of our actions.

You who are here today, leaders in the diverse fields which bear on these troublesome problems, must help us in government move toward a deeper insight into man's relationship with his environment. This is a heavier responsibility than may be readily apparent, for the focus government takes in ecology will affect the health and welfare not only of all our citizens living today—but of millions more yet unborn.

If I may, I would like to close with another story about an airline pilot who was flying a hundred passengers across the country in a heavy storm. It was such a violent storm that all on board were terrified. Finally, the pilot's voice came over the intercom saying "Ladies and Gentlemen, I know you're concerned and I would like to report two things to you—one represents good news and the other bad news.

"I'll give you the bad news first—we're lost.

"The good news is that we're making record time."

In our understandable haste to make this a better world for many, by all means, let's make "record time." But let's make sure we know where we are going, too.

Thank you very much.

Summary of Discussion Following Representative Laird's Remarks

Advances in environmental health programs will require the combined effort of Federal, State, local, and private organizations. The Federal responsibility should be concerned primarily with directing the efforts, communicating the need for action to other organizations, and informing the public of the need for action. To be effective, it is important that Federal environmental health activities be brought together in one organization, otherwise their efforts are likely to be uncoordinated and ineffective.

The public is tired of the separate categorical approach (air, wastes, etc.) to environmental health and an ecological view can be "sold" effectively, Mr. Laird stated, adding that the use of block grants for environmental health would be an improvement over categorical grants for water pollution, air pollution control, etc.

Tax credits or other forms of financial incentives to industry were generally favored by the Congressman, who said that the new draft bill on the tax credit for air and water pollution and solid-waste disposal provides for tax incentives greater than 7 percent and would allow for fuel substitution, process changes and other approaches as well as for new equipment.

To help provide additional funding for environmental health, it would be desirable for Congress to move toward revenue-sharing with States and toward tax credits to industry but such legislation is not likely to be enacted in the first session of the current Congress. In that connection, it was felt that comprehensive environmental health planning is a "desirable first step toward full revenue-sharing with States and local agencies."

GROUP DISCUSSIONS on ISSUES and IDEAS on CONSUMER PROTECTION and HEALTH ECOLOGY

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Summary of Small Group Discussions

Introduction

SYMPOSIUM PARTICIPANTS were divided into three groups on the afternoon of November 25 and into six groups on the afternoon of November 26 to discuss issues raised by speakers in the morning sessions. The group discussions were moderated by Commissioners of the three Administrations within Consumer Protection and Environmental Health Service (CPEHS) and by other key CPEHS personnel.

Discussions in the group sessions ranged over many issues and problems. The following summary presents the major issues raised and an indication of the various viewpoints expressed regarding the issues.

Centers of Excellence for Human Ecology

THERE WAS VIRTUAL UNANIMITY as to the need for centers to direct their attention to human ecology. It was agreed that a firm definition of the purpose of ecological centers needs to be established as the first step in determining the organizational setting for such centers. There was general agreement that such centers, to be effective, will require an interdisciplinary staff oriented to the mission of ecological investigation. A staff of at least 15 to 20 individuals is needed to form a "critical mass" for the centers.

The need for different types of ecological centers or at least centers with multiple functions was expressed. These various functions might include research, training, development of concepts and strategy (think-tank approach), and development action programs or projects. One discussion group saw the need for four types of organizations, not necessarily "ecological centers," to address themselves to human ecology:

1. An organization (similar to the Rand Corporation) which is mission-oriented and is concerned on a broad basis with problem solving, strategy development, and evaluation.

2. Academic institutions for basic and applied research, demonstration, public awareness, training, and recruitment.

3. Information clearinghouses to provide a broad spectrum of data inputs to action agencies and the public.

4. Governmental institutions to achieve, among other things, coordination.

There was considerable debate on the relationship of the university to the centers. One view was that universities, by tradition, are discipline-oriented, react relatively slowly to changing needs, and are thus not well suited to operate ecological centers. A counter view was that modern universities, with proper mission-oriented Federal support, can mount the necessary effort. Discussants generally agreed that the potential for contribution by universities is highest in the areas of research and training, and lowest in terms of operating action programs affecting the public.

There was general agreement that, whatever form the ecological centers eventually take, universities, Government, industry, and nonprofit organizations should be involved.

Environmental Data

AN IMPORTANT NEED is expanded effort in the collection, analysis, and dissemination of environmental data. Such data are needed to understand current problems, to measure progress in accomplishing environmental improvement, and for use in setting criteria and standards.

Important considerations in establishing environmental data systems include:

- A variety of data must be collected including information on subclinical health effects (as measured by absenteeism from work, school, etc.), morbidity and mortality, levels of various environmental contaminants, and new control technology.
- Data must be more current than are now available.
- Plans must be made on a long-range basis to insure continuity of inputs over a long period.
- Standardized techniques must be used for reporting and analysis.
- Systems must be developed to insure that data are available to a wide variety of users in the most useful form.
- Agencies which already collect relevant data, such as the Environmental Science Services Administration, should be fully informed of environmental health data needs so that existing programs can be adapted to meet their needs.
- An epidemiological approach should be taken to the problems of human ecology and the environment, using sound environmental data as a basis for investigation.
- CPEHS should be the principal coordinator of efforts to establish and maintain an environmental data system.

Neighborhood Environmental Health Programs

MANY ENVIRONMENTAL PROBLEMS, particularly in ghetto areas, can be solved with existing technology but require new program approaches. It was noted that personal health care programs have been given a good deal of recent attention at the neighborhood level but that environmental programs necessary to complete the health picture have been lacking.

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The suggestion was made that CPEHS join forces with other agencies to demonstrate environmental control techniques in ghetto areas. Information gained in such demonstrations could then be applied on a broader scale.

Public Awareness and Involvement

THERE WAS GENERAL RECOGNITION that an informed and involved public is essential to success of environmental improvement programs. The benefits of an informed and involved public include better implementation of program efforts and increased support of environmental programs in the Congress, State legislatures, and local governing bodies. The feeling was expressed that an informed public is more effective in securing progress than are experts using sophisticated and complex arguments.

It was agreed that the public is genuinely concerned with specific problems such as air and water pollution but that public awareness of the complexities and subtleties of the overall environmental problem is lacking. Efforts to involve the public in the solution of environmental problems was felt to be lagging behind efforts to simply inform the public of problems.

This awareness and involvement must be generated by effective communication of knowledge to the public from all levels of government, from universities, and from public and private organizations. The citizenry involved to the greatest extent should be the group most affected, by the specific problems. Involvement can best be achieved through citizen participation in several phases of environmental programs, such as planning, setting of goals, and implementation, rather than by presentation of a completed plan to the public with a view to citizen assistance in its implementation.

Overstatement of the problem to shock the public into action, and promises for control which cannot be kept, were cited as serious mistakes in public relations.

Organizational Relationships

PARTICIPANTS RECOGNIZED the scope and complexity of the Federal effort in matters affecting the environment and the fact that many Federal agencies have responsibilities to carry out programs in specialized areas of the field.

The need to establish coordination of Federal environmental efforts is of paramount importance. Existing arrangements for Federal coordination, such as interagency committees, were noted to be helpful but not fully capable of obtaining full coordination. Several possibilities for improving coordinaton at the Federal level were mentioned, including the following:

- Establishment of an organization at the White House level with authority to provide broad leadership and coordination.

- Formation of a Joint House-Senate Committee on the Environment.
- Designation of CPEHS as the "lead agency" in the Executive Branch of Federal Government for man-environment and human ecology matters. (Note: See Wednesday morning discussion for more on this item.)
- Establishment of "convener authority" for the Department of Health, Education, and Welfare similar to the authority held by the Department of Housing and Urban Development for model cities programs.
- Establishment of a formal interagency body for environmental matters with authority comparable to that of the Water Resources Council.

Questions were raised concerning relationships between CPEHS and other environment-related programs within the Department of Health, Education, and Welfare, such as:

- The National Institute for Environmental Health Sciences, National Institutes of Health.
- Environmental manpower programs of the Bureau of Health Manpower, National Institutes of Health, and
- Environmental aspects of comprehensive health planning, administered by the Health Services and Mental Health Administration.

Economic Analysis

ONE GENERAL VIEW was that economic analysis is potentially a tool of major importance in establishing program priorities and in demonstrating the benefits of environmental control programs. A differing view was that by nature, environmental problems do not lend themselves to economic analysis and benefits can be established on other than economic bases.

Proponents of cost benefit, cost effectiveness, and other economic analysis techniques recognized a degree of imprecision in the techniques but pointed out that their application to environmental problems could produce valuable insight. In further support of economic analysis techniques, it was noted that benefits of environmental control programs are not always obvious and that economic techniques can be used to highlight such benefits.

Those Symposium participants who did not support, fully, the application of economic analysis to environmental problems felt that other approaches such as motivating the public to seek improvements in the environment for aesthetic reasons, form a better basis for securing progress than do economic arguments. The lack of precision and definition in current economic techniques and their potential for obscuring fundamental benefits of environmental control programs were cited as further limitations to the application of economic analyses to environmental problems.

Population Problems

EXAMPLES OF ECOLOGIC imbalances caused by overcrowding of certain animal species were cited to illustrate potential similar human ecological problems.

There was consensus that environmental programs must be planned with full recognition of the impact of expanding population and that CPEHS should maintain awareness of population trends and related matters in order to estimate various potential degrees of environmental contamination. Divergent views were expressed regarding the need for population control programs and the involvement of CPEHS in any such effort. One view was that population control programs are vitally needed to head off impending major environmental problems and that CPEHS should take an active part in these programs. A differing view was that "first-order" problems such as overpopulation are usually ameliorated by other factors such as new technology and the adaptability of people to change, thus direct action to control population is not needed at this time.

Action Items

THROUGHOUT THE DISCUSSION, suggestions for action to secure progress in improving the environment were made. The following is a brief summary of a number of these points:

- There is need to orient our thinking to action programs using existing knowledge and responding to expressed public desires. Although we must continue to acquire new knowledge, action on problems which we know how to solve should not await further refinement of knowledge.
- A clearcut, comprehensive national policy for environmental improvement must be established. Highest priority should be given to action providing the greatest improvement for the largest number of people.
- The rapidly increasing allocation of resources to the delivery of health service represents an imbalance in the Nation's approach to the solution of its health problems. The Nation should give increased support and attention to the understanding and control of environmental factors responsible for health problems.
- National policy should include the concept that known environmental hazards should not be allowed to increase in areas where specific adverse health effects cannot be presently demonstrated. Community noise is cited as an example.
- Official governmental agencies, universities, and other organizations should increase their efforts to demonstrate to industry the economic and related benefits associated with their involvement in environmental control programs.
- Reports on the environment and/or health aspects of human ecology have been prepared by several Federal Executive agencies, the Congress, numerous Task Forces, and others. CPEHS should undertake a review of these materials and summarize the major goals and other elements which have been outlined.

- CPEHS should assume responsibility for encouraging opportunities for interdisciplinary research, as well as training, demonstration, and other activities within and outside of CPEHS. Personnel capable of solving complex interdisciplinary problems are needed to lead efforts in the environmental and human ecology field.
- Consideration should be given to conducting additional symposia on human ecology. The invitees should be given the opportunity to contribute to the development of agenda.

Summary of Closing Session

Dr. John J. Hanlon, Deputy Administrator of CPEHS, summarized the major issues and conclusions developed during the Symposium and asked for discussion from the floor. Viewpoints expressed in the discussion included:

- Government agencies are not accepting responsibility for certain important and complex issues which do not fall squarely in their areas of authority. As a result, concerted action is not being taken on such problems as population control and the mental health aspects of environmental stress.
- Increased appeals to the public to become more concerned and involved in environmental problems for which there is no ready solution, or for which action cannot be obtained, may cause increased frustration and stress and thus do more harm than good.
- Full attention must be given to social and psychological factors along with the biophysical concerns in environmental programs. There has been a good deal of talk about social and psychological aspects but little action.
- Action can be taken now to improve environmental conditions, particularly in urban areas, despite limited resources for categorical environmental programs. Resources and approaches not used in the past can be brought to bear on evironmental problems. Examples might include better enforcement of housing codes and more realistic welfare program requirements.
- Data show that health and social problems are most prevalent in the poorest sections of our cities. Early emphasis should be given to applying existing technology to environmental problems, to providing proper personal health services, and to solving social problems. Past categorical approaches must give way to a comprehensive focus on the urban environment.
- The factors which permit enforcement agencies to condone the creation and continuance of such problems as sub-standard housing should be evaluated and techniques developed to motivate enforcement agencies to take responsible action.

Closing discussions concerned the proposal by a symposium participant that a resolution be adopted urging that CPEHS be designated as the lead agency in the Federal establishment for environmental quality. Further discussion centered around the meaning of the term "lead agency" and functions which such an agency would carry out. It was agreed that the lead agency concept did not imply transfer of budget base, transfer of program activities, or reduction in authority and responsibilities of other agencies. Instead, the lead agency would serve as the Federal spokesman, coordinate Federal programs, and provide leadership in seeing that environmental issues are given proper consideration throughout the Federal government's activities. A number of participants agreed that the lead agency concept would be useful in the environmental and human ecology field and that CPEHS should be given the responsibility. Others felt that this broad mission would overtax the resources of CPEHS to the detriment of specific programs for which CPEHS has direct responsibility. There was general agreement that CPEHS should provide leadership and set the proper example for Federal efforts in the environmental area, with a particular focus on man. Concerted action is also needed at State and local levels to accomplish the overall needs in environmental health.

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